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Yano

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(54) **PROTECTION DEVICE FOR AN INK CARTRIDGE STORAGE UNIT**

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This patent is subject to a terminal disclaimer.

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B41J 2/17 (2006.01)
B41J 2/175 (2006.01)

(52) **U.S. Cl.** **347/29**; 347/84; 347/86

(58) **Field of Classification Search** 347/22, 347/37, 84–86, 108, 29; 206/320
See application file for complete search history.

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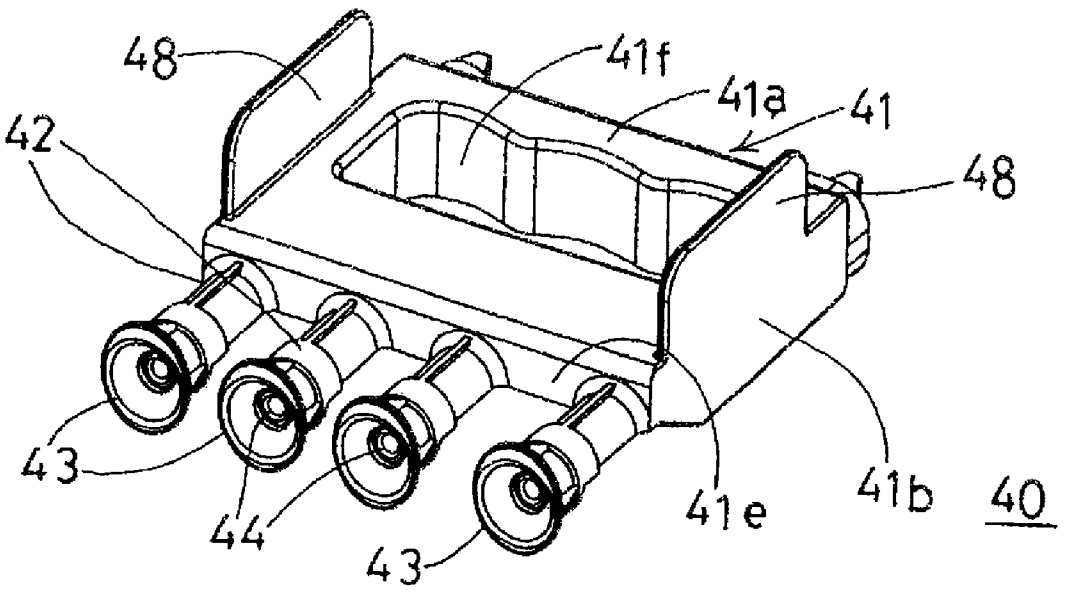
(57) **ABSTRACT**

A protection device for an ink cartridge storage unit having an ink inducing member is provided with a supporting beam, a funnel member having a narrow conical end and a wide conical end, the narrow conical end being connected to a distal end of the supporting beam, and an elastic cap arranged inside the funnel member. The elastic cap seals the ink inducing member in an engaged state. In the course of removing the protection device from the ink cartridge storage unit, the protection device can be lifted in the upper direction. The upper rim of the wide conical end makes contact with the rear surface of the ink cartridge storage unit in due course. As the protection device is lifted further, the part of the elastic cap is constricted, and the upper rim of the wide conical end functions as the fulcrum for the leverage.

9 Claims, 14 Drawing Sheets



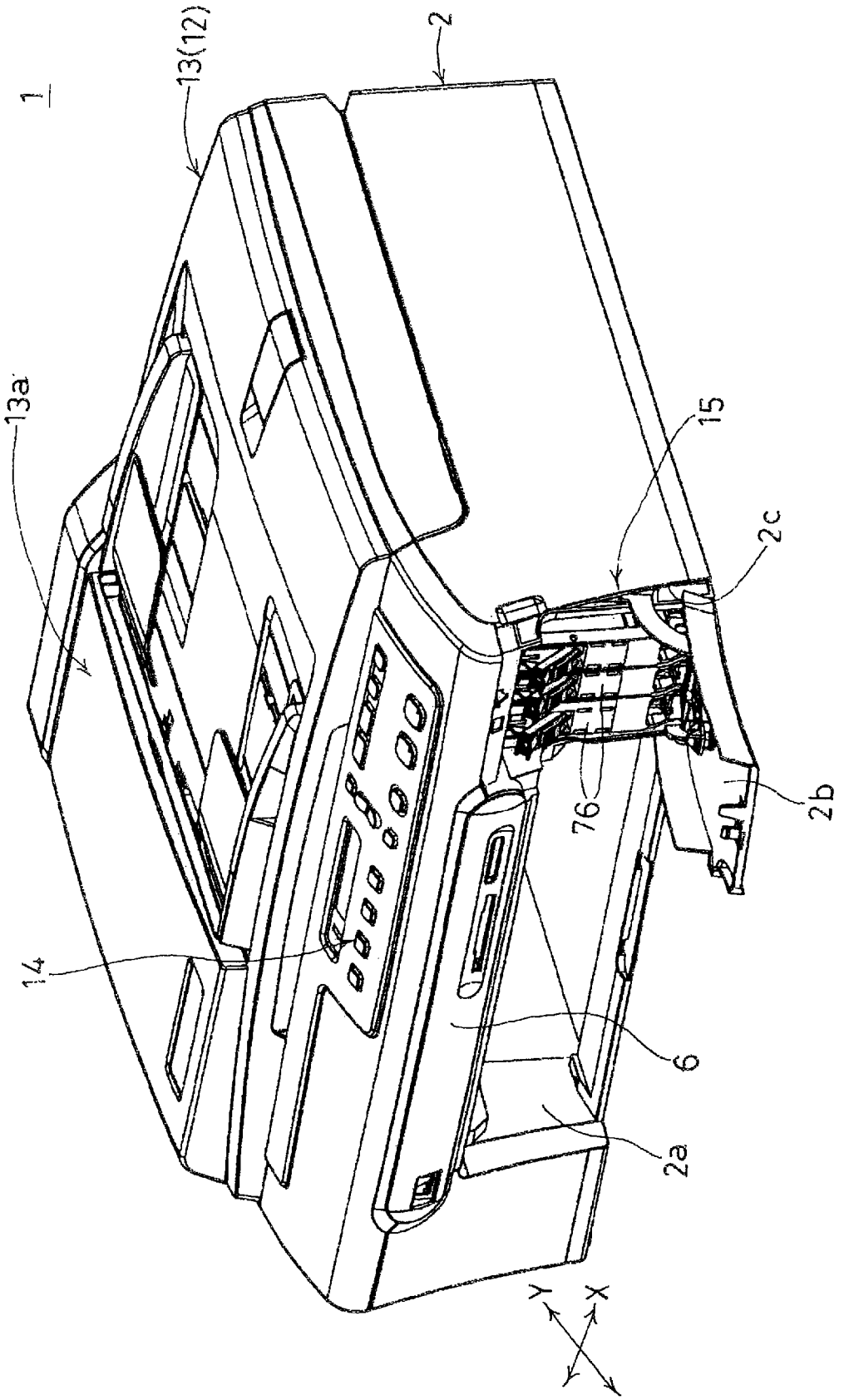
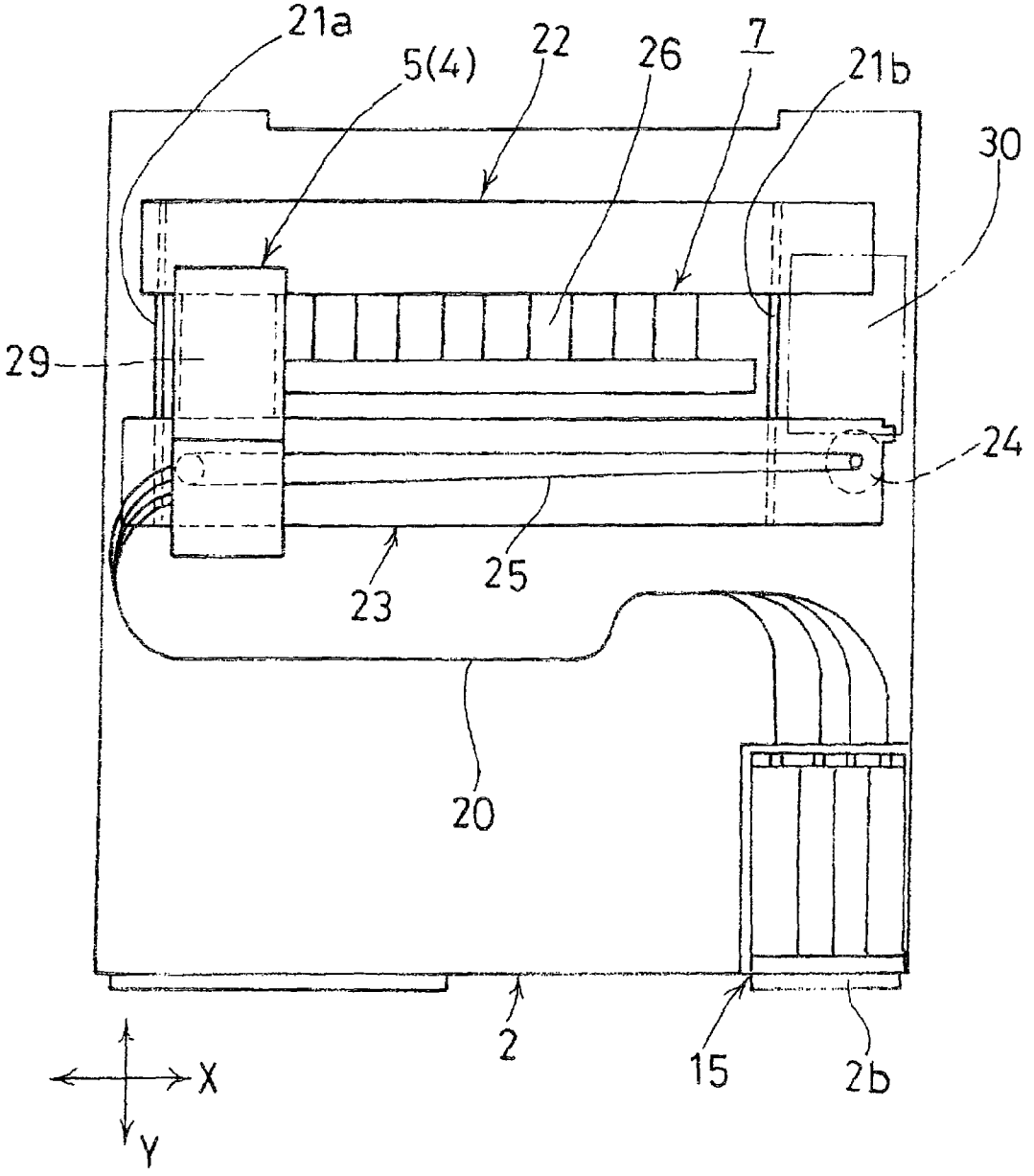


FIG. 1

FIG. 2



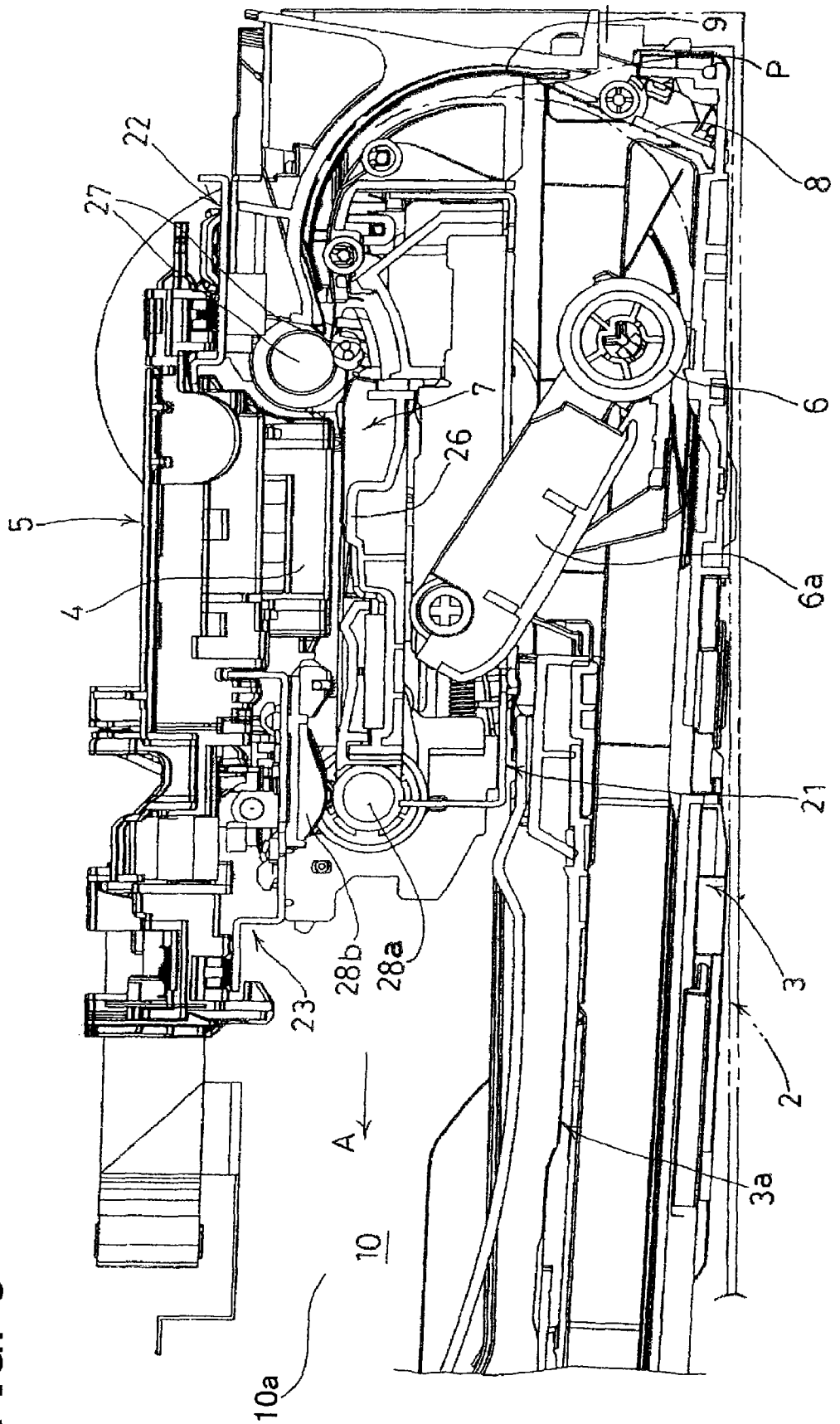


FIG. 3

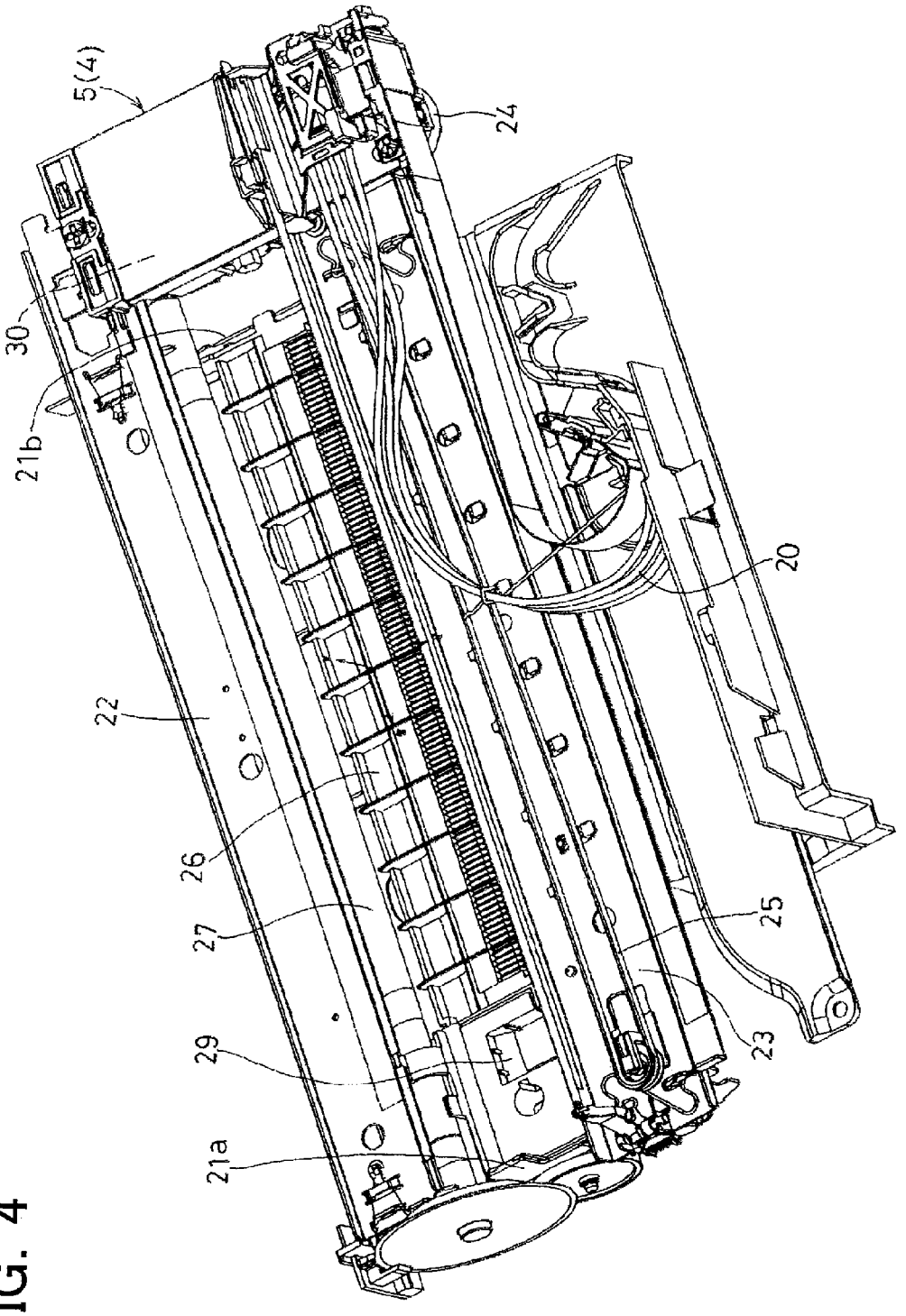


FIG. 4

FIG. 5

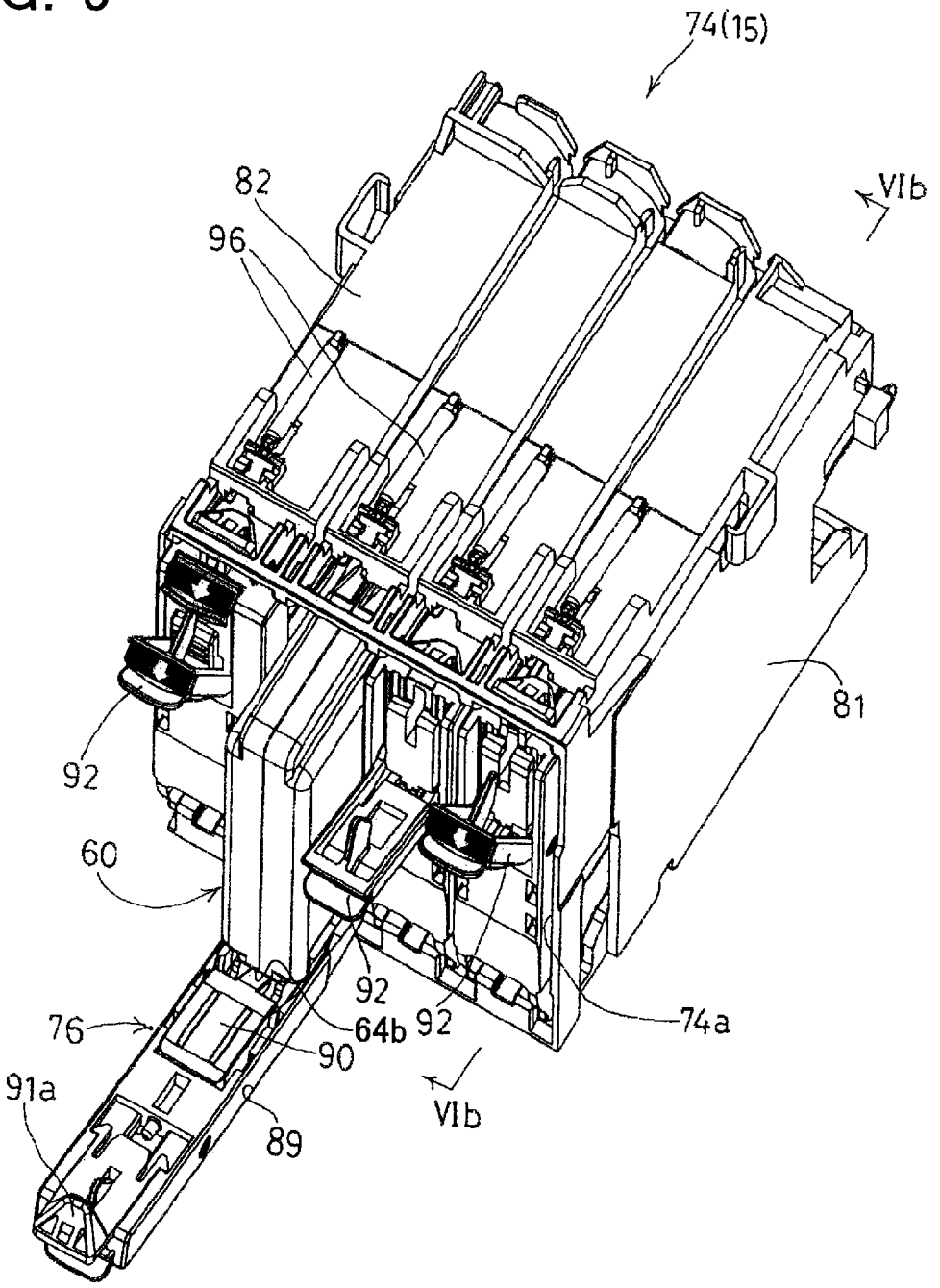
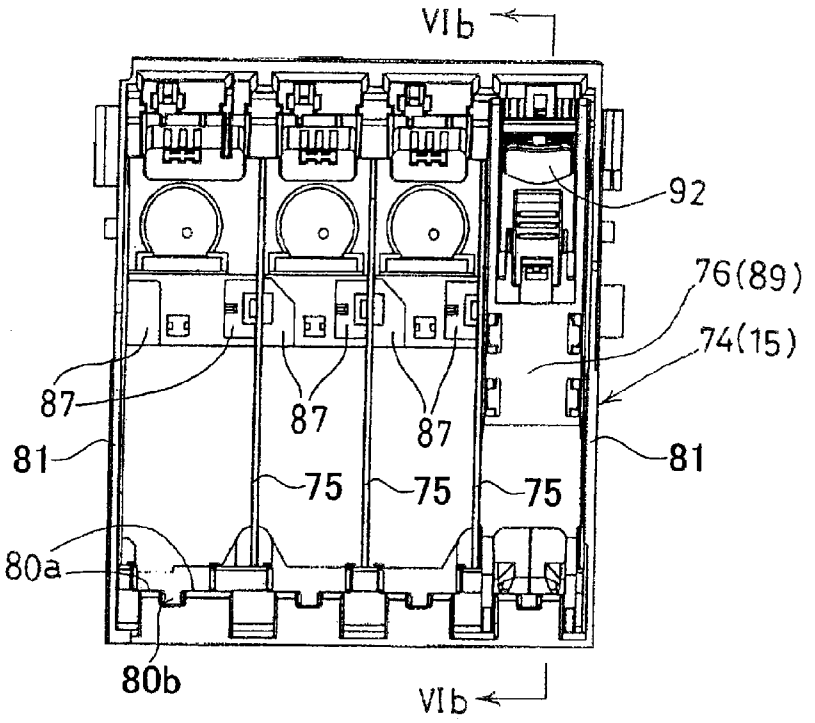


FIG. 6A


VIb
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74(15)
87
87
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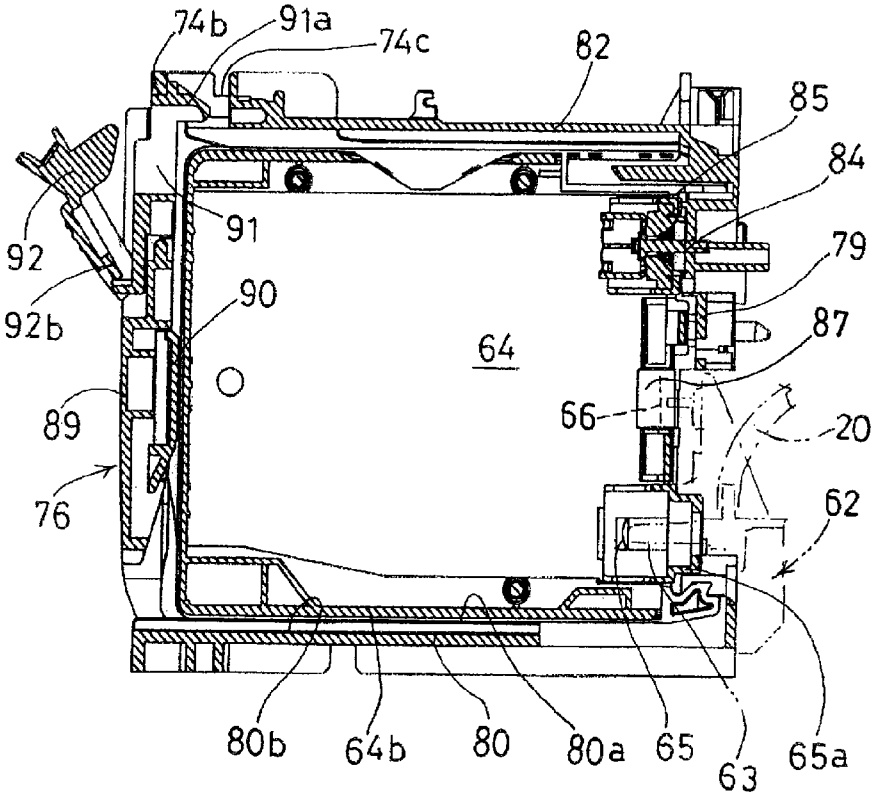
80b
VIb

FIG. 6B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74c
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65a

FIG. 7A

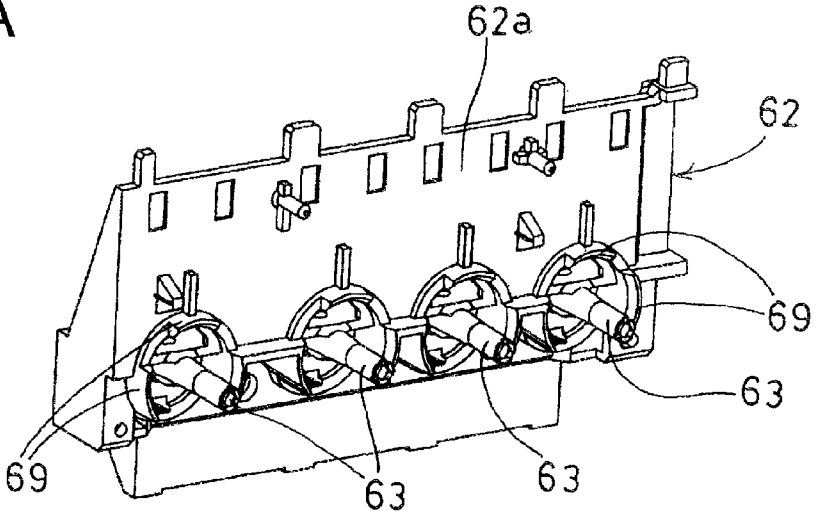


FIG. 7B

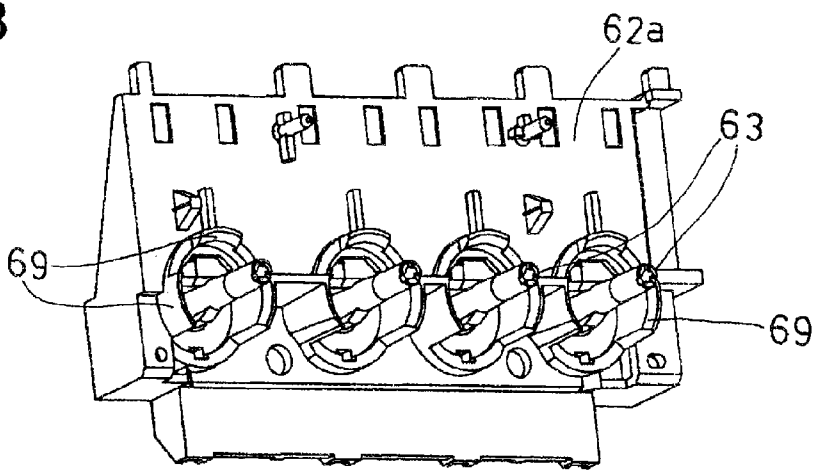
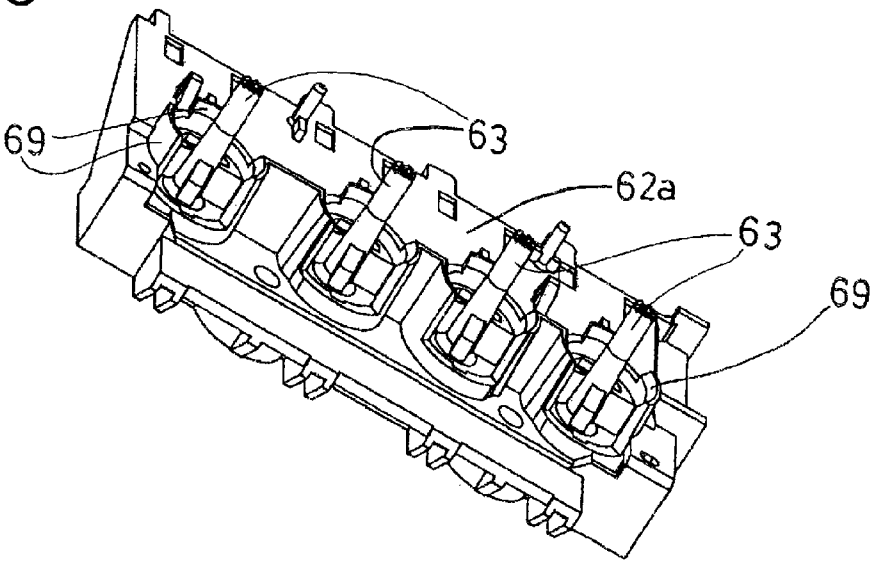
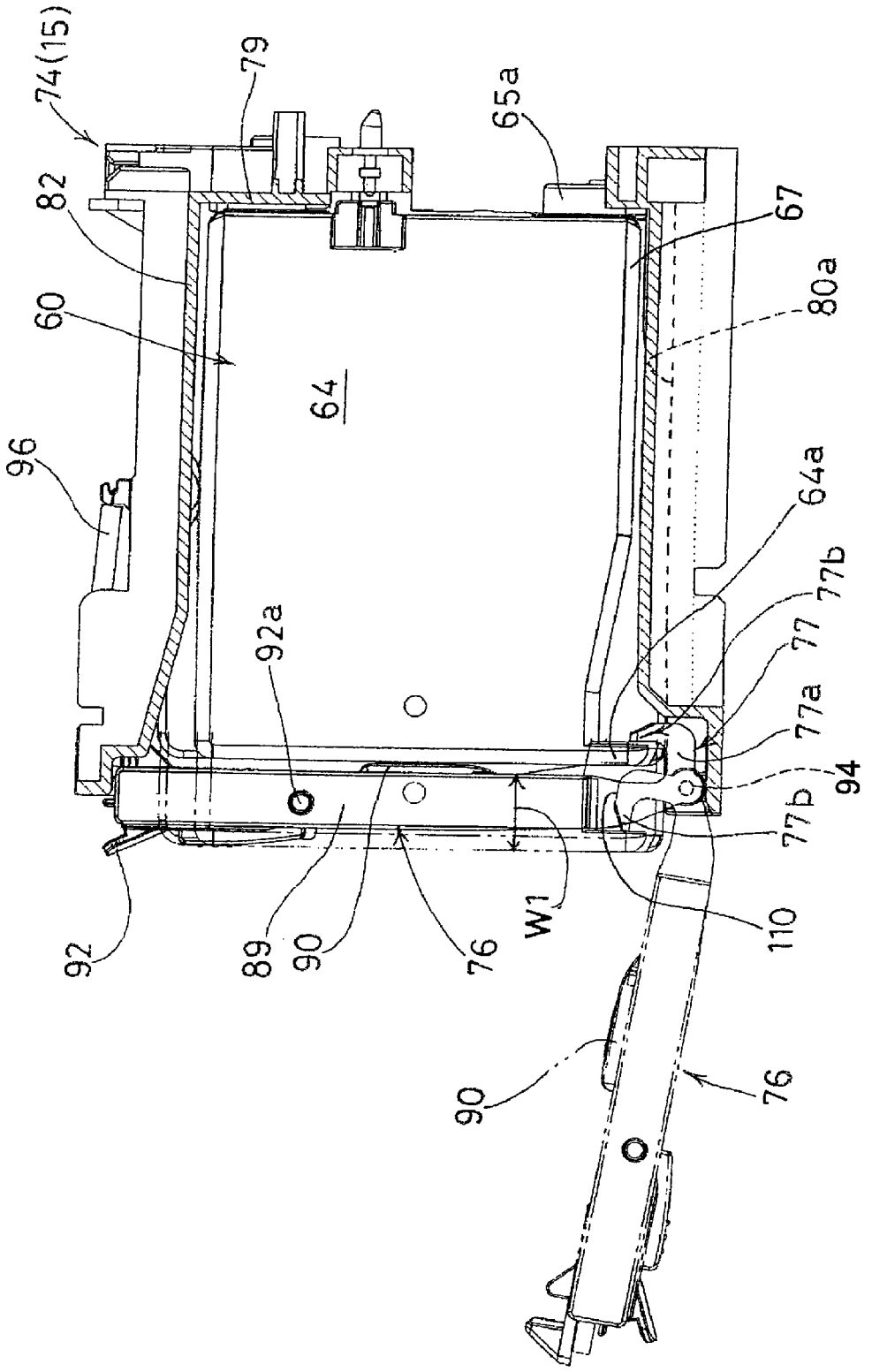


FIG. 7C

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65a
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77b
W1
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76
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76

FIG. 8

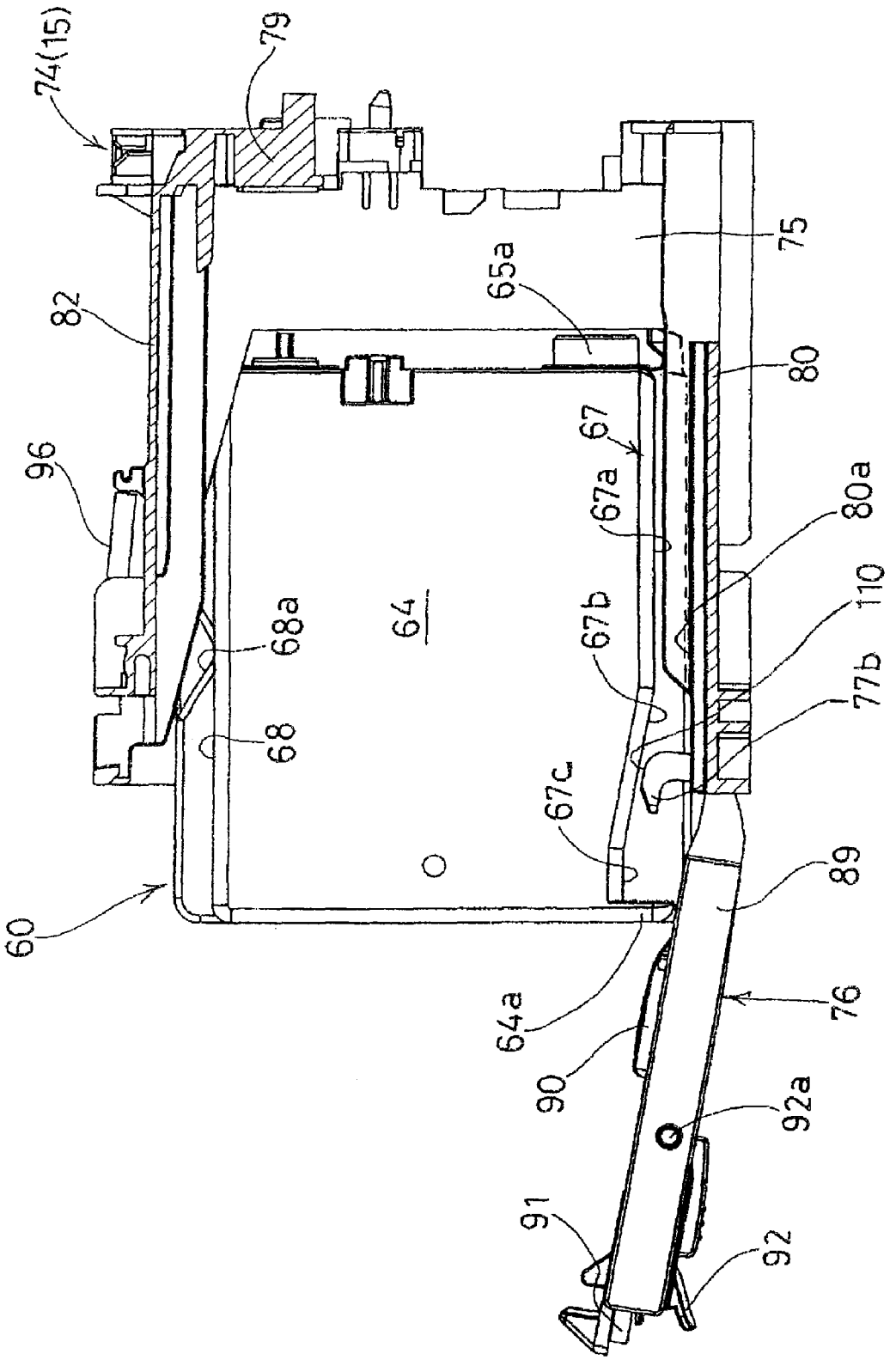
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FIG. 9

FIG. 10A

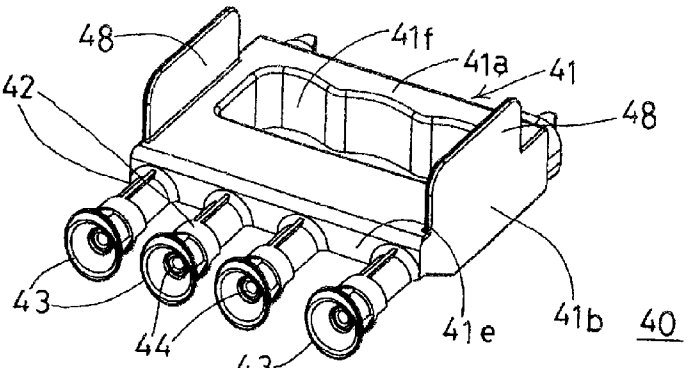


FIG. 10B

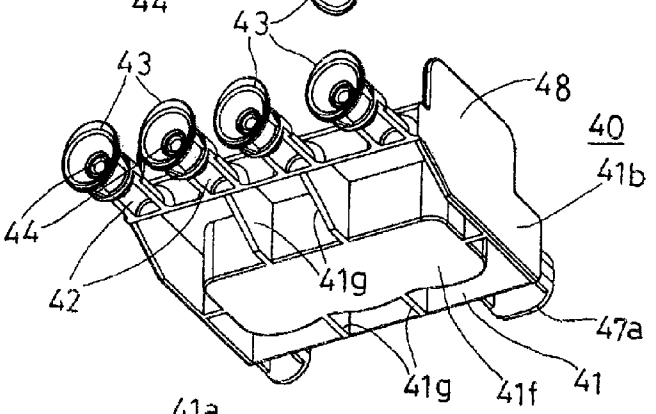


FIG. 10C

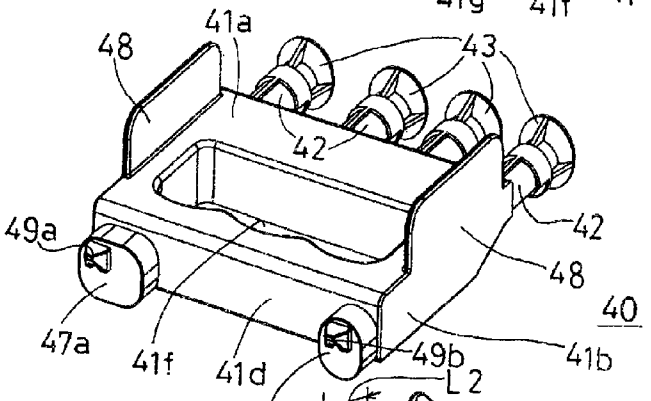


FIG. 10D

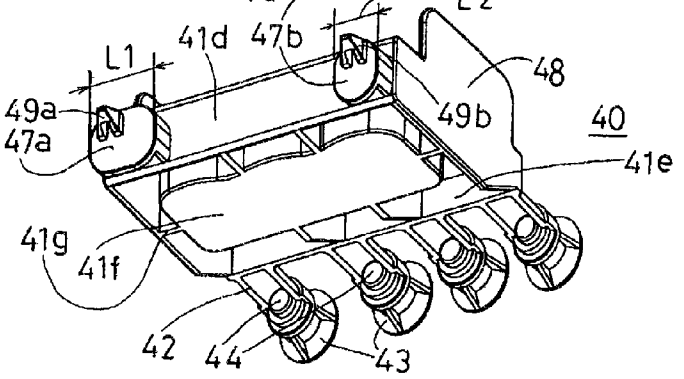
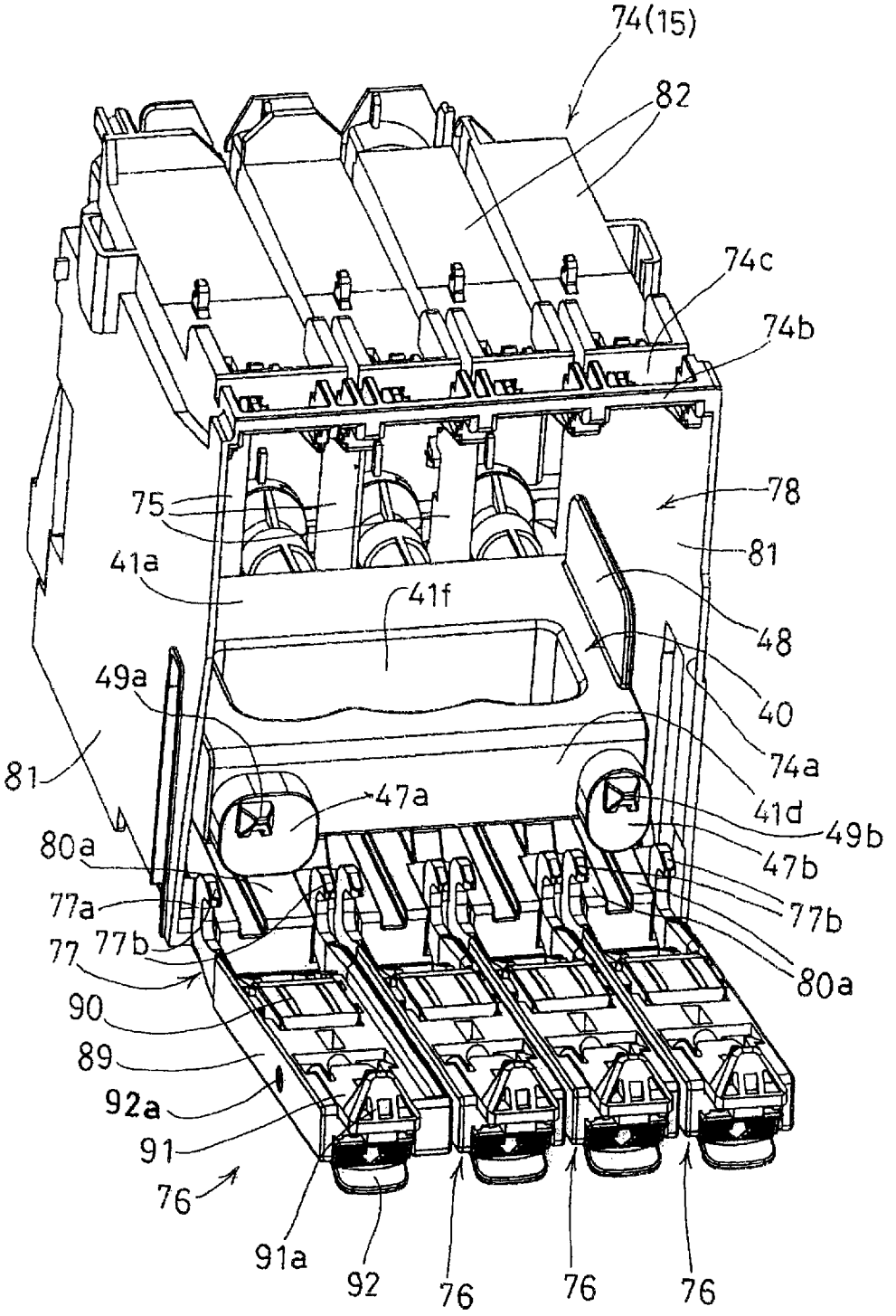


FIG. 11


74(15)
82
74c
74b
78
75
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41a
41f
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49a
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74a
81
47a
41d
49b
80a
47b
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FIG. 12A

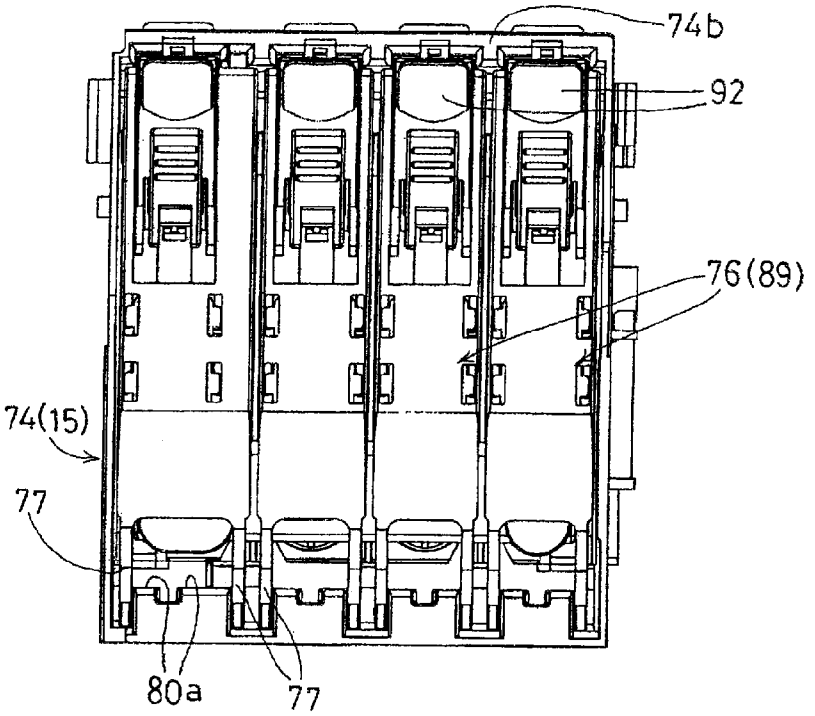


FIG. 12B

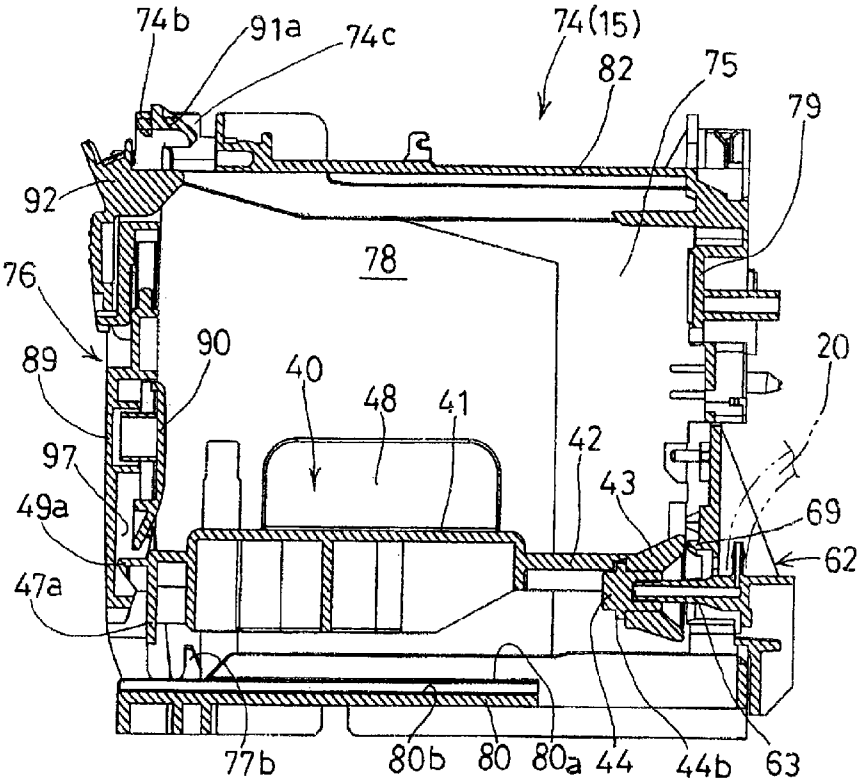


FIG. 13A

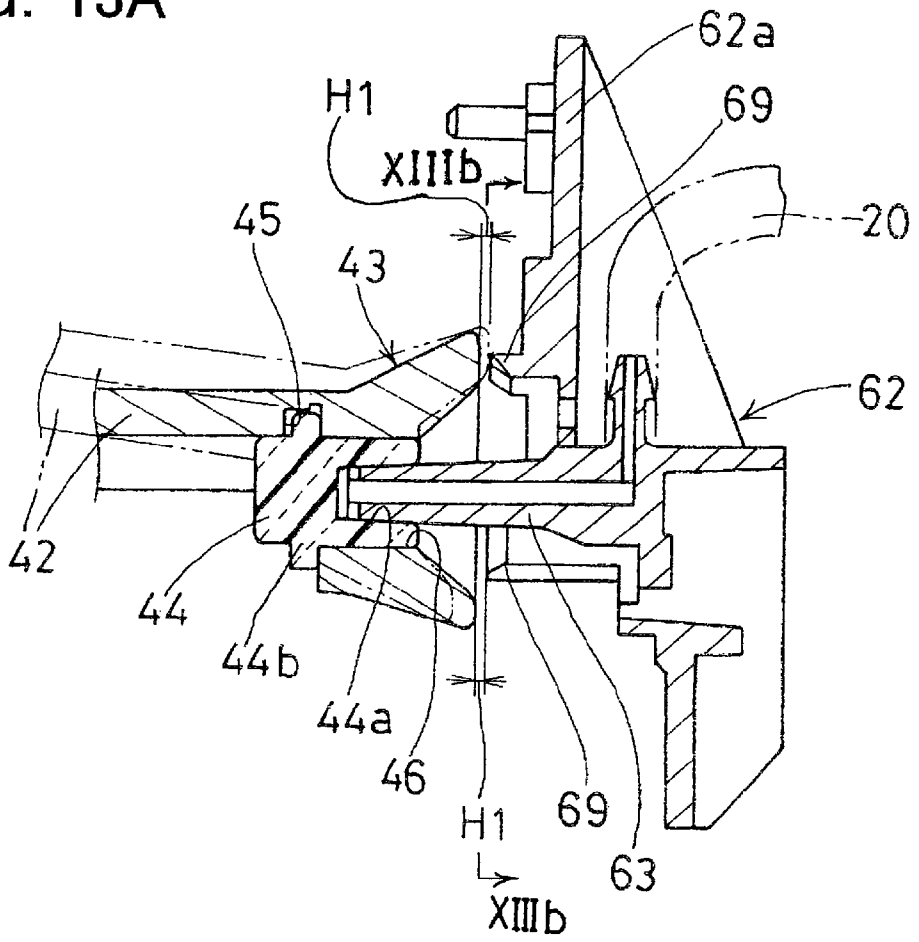


FIG. 13B

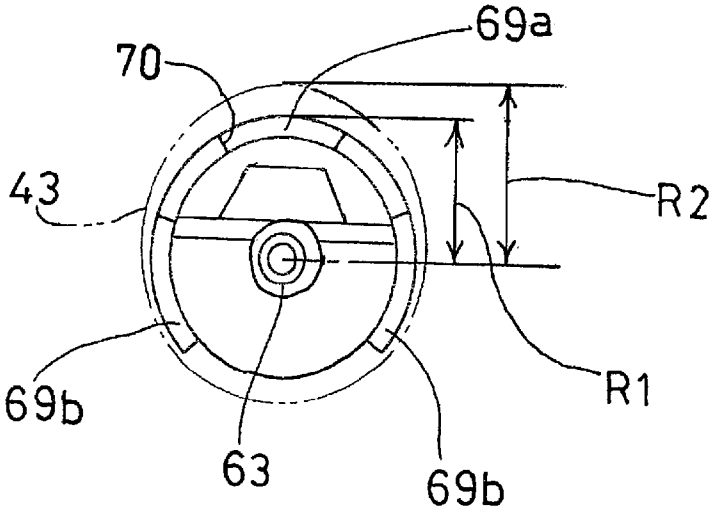
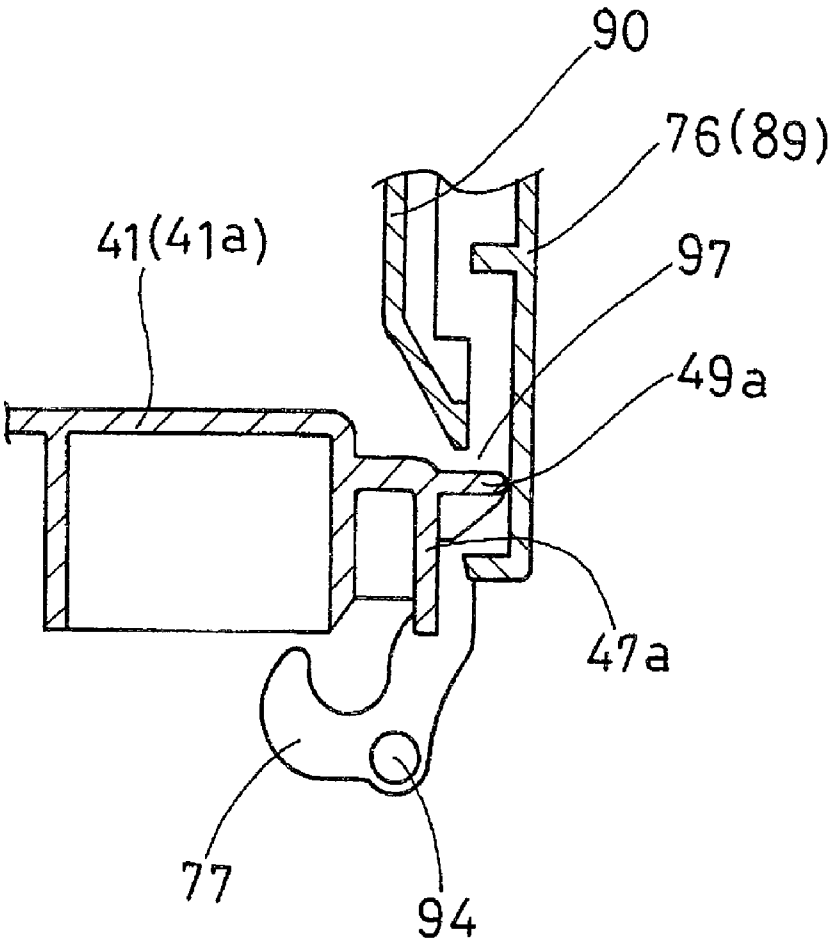


FIG. 14



PROTECTION DEVICE FOR AN INK CARTRIDGE STORAGE UNIT

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to Japanese Patent Application No. 2006-100498, filed on Mar. 31, 2006, the contents of which are hereby incorporated by reference into the present application.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a protection device for a storage unit (a refill unit) of ink cartridges utilized in an ink jet printer.

2. Description of the Related Art

An ink jet printer known in general has a housing in which a print head, one or more ink tanks (ink cartridges), and a carriage is installed. The print head includes a nozzle for discharging ink, and is arranged on the carriage. The carriage is able to move in the perpendicular direction with respect to a printing medium (a sheet of printing paper, for example); that is, the carriage is able to move in the main scanning direction. The print head is connected to the ink tank, and discharges the ink provided therefrom via the nozzle. The printing medium is conveyed through the housing of the ink jet printer, and the ink discharged from the nozzle is printed thereon.

The ink jet printers can be roughly categorized into two types: an on-carriage type, and an off-carriage type. Such categorization can be made based on the arrangement of the ink cartridge. The on-carriage type and the off-carriage type both include a storage unit, or a storage case for detachably storing the ink cartridge. The on-carriage type has the storage unit arranged on the movable carriage. With this type of carriage, the ink is provided directly from the storage unit to the print head. On the other hand, the off-carriage type has the storage unit arranged inside the housing, but not on the movable carriage. The ink cartridge stored in the storage unit is connected to the print head by a relaying member; for example, an ink tube. The ink is provided from the remote storage unit to the print head that is supported on the carriage via the ink tube.

With either of the types of ink jet printers as described above, the ink cartridge must be replaced with a new one, or be refilled, when the volume of remaining ink becomes insufficient.

With the typical types of ink jet printers as described above, the storage unit has an ink inducing member that provides ink to the print head. Correspondingly, the ink cartridge has a connecting portion, such as an ink providing valve. To provide the ink to the print head from the ink cartridge, the ink inducing member of the storage unit is connected to the connecting portion of the ink cartridge. In a case where the ink inducing member is in the shape of a narrow needle or tube, the ink inducing member is easily bent or broken in the course of installing and removing the ink cartridge to and from the storage unit. Thus, a guiding portion, for example, a plurality of guiding ribs or a guiding tube section are formed on the periphery of the ink inducing member, while an insert tube corresponding to the aforementioned guiding ribs or the guiding tube section is formed on the connecting portion of the ink cartridge, to insert therein.

Inkjet printers of both the on-carriage type and the off-carriage type undergo a print test before shipment. The print test is performed to confirm that the printing mechanism is functioning. In such a test, one or more ink cartridge is installed in the storage unit, and after the print test, the ink cartridge is removed from the storage unit before shipment. The ink inside the print head can be left or removed prior to shipment. In the case where the ink is removed from the print head, the print head is refilled with a preservative liquid which has the same characteristic as the ink without pigments or dyestuffs. Then, a protection device, such as a protection cap or a dummy cartridge (that is, a cartridge with no ink inside), is installed in the case to cover the ink inducing member. The protection device prevents the leakage of the ink or the preservative liquid (the term "liquid" will be used as the general term for both the ink and the preservative liquid in the description below). The surface of the print head on which the nozzle is arranged is also covered with a nozzle cap to prevent the leakage of the liquid, and for the protection of the nozzle. Such a technique is taught in the Japanese Patent Application Publications No. 2002-79690, No. 2004-230857, No. 2005-238857, and No. 2003-54000.

Hence, in order to seal the tube or needle shaped ink inducing member, a rubber cork (see FIG. 3 of the Japanese Patent Application Publication No. 2002-79690), or a sealing portion (see Japanese Patent Application Publication No. 2005-238857 and No. 2003-54000) is arranged on the protection device.

In the above-mentioned case of sealing the tube or needle shaped ink inducing member with the protection device, the rubber cork or a rubber cap is arranged on the protection device. However, if the protection device is installed or removed in an improper position or angle, the ink inducing member is bent or broken.

Moreover, in the course of transporting the ink jet printer, the environmental condition of the ink jet printer may change; for example, following impact from vibrations due to transportation, the seal between the protection device and ink inducing member may be loosened, resulting in ink leakage. Or, a change in temperature, and/or change in atmospheric pressure may occur. If air and liquid remain inside the sealed portion, the aforementioned changes cause the volume of the air and liquid to change, resulting in a loosening of the seal and ink leakage. Therefore, the cork (or the rubber cap) of the protection device must be sealed tightly in order to prevent the occurrence of undesirable conditions described in the above-mentioned cases. For this reason, the cork (that is, the protection device) is tightly inserted into or engaged with the ink inducing member.

In such case, however, excessive force is required in the process of removing the protection device, and if the removal direction is not parallel to the ink inducing member, the ink inducing member is bent or broken.

BRIEF SUMMARY OF THE INVENTION

The objective of the present invention is to provide a protection device for the ink cartridge storage unit, maintaining the essential function of preventing the leakage and the dehydration of liquid as well as the function of preventing the bending and breaking of the ink inducing member, while also ensuring that the protection device can be installed and removed easily. To achieve such an objective, the following technique taught in the present specification was developed.

The protection device disclosed in the present specification is applied to an ink cartridge storage unit having a storage main body with one side having an opening, an ink inducing member arranged on a surface of the main body facing the side having the opening, in a manner that the ink inducing

member vertically protrudes inside the main body with respect to the surface. The protection device includes a main body, a supporting beam connected to the device's main body, the supporting beam protruding in a horizontal direction with respect to the ink inducing member, a funnel member having a narrow conical end and a wide conical end, the narrow conical end being connected to a distal end of the supporting beam, and an elastic cap arranged inside the funnel member, and the elastic cap seals the ink inducing member in an engaged state. When the protection device is angled toward a direction in the aforementioned engaged state, the part of the wide conical end corresponding to that direction makes contact with the surface where the ink inducing member is arranged and slides thereon.

The ink cartridge storage unit is able to store an ink cartridge. The ink cartridge can be inserted through the opening, and is connected to the ink inducing member that is arranged on the rear side surface. Ink stored inside the ink cartridge is supplied to a print head through the ink inducing member. The protection device is configured to attach to the ink inducing member as an alternative to the ink cartridge. The protection device can also be inserted through the opening. The funnel member guides the ink inducing member and the elastic cap seals the ink inducing member.

In the course of removing the protection member from the storage main body, the protection device can be lifted in the upward direction. The upper rim of the wide conical end makes contact with the rear surface of the storage main body in due course. As the device's main body is lifted further, the part of the elastic cap that is pressed against the ink inducing member is constricted, and the upper rim of the wide conical end functions as the fulcrum for the leverage (lifting). The upper rim making contact with the rear surface slides downward, while the position of the elastic cap with respect to the ink inducing member is shifted in accordance with the constriction. As the result, the elastic cap can be taken off of the ink inducing member. After the seal between the elastic cap and the ink inducing member is loosened, the protection device can be pulled out of the storage main body. Even in a case where the protection device is tightly sealed the ink inducing member, the protection device can be easily removed from the ink cartridge storage unit with small effort.

In a case in which the ink cartridge storage unit includes a guiding rib arranged along the outer periphery of the ink inducing member, the guiding rib having a surface facing the opening, it is preferred that the funnel member is configured so that a clearance is maintained between the wide conical end of the funnel member and the guiding rib of the ink cartridge storage unit in the engaged state. When the protection device is angled toward a direction, the part of the wide conical end corresponding to the direction makes contact with the surface of the guiding rib and slides thereon.

The ink cartridge storage unit may include a guiding rib on the outer periphery of the ink inducing tube. The guiding rib is formed to guide the ink cartridge in the course of insertion, and protects the connection of the ink cartridge and the ink inducing member. However, in the course of removing the protection device, if the upper rim of the wide conical end of the funnel member is caught on the side surface of the guiding rib while lifting the protection device, the protection device cannot be efficiently removed. In the aforementioned configuration, the upper rim of the wide conical end makes contact with the top surface (that is, the surface facing the opening of the storage main body) of the guiding rib. The protection device can be removed easily without the leverage being inhibited.

Furthermore, due to the clearance maintained between the wide conical end of the funnel member and the guiding rib of the ink cartridge storage unit, when the elastic cap and the ink inducing member are engaged with each other, even in a case in which the ink leaks from the ink inducing member, the funnel member can be kept clean.

With the aforementioned protection device, it is also preferred that a plurality of supporting beams ordered in a line is connected to the device main body, and a part of the wide conical end is elongated in an orthogonal direction with respect to the direction of alignment of the supporting beams.

An ink jet printer that is able to print colored images uses a plurality of colored ink. In general, inks of different colors are contained in different ink cartridges. Hence, the ink cartridge storage unit may store a plurality of ink cartridges, and a corresponding number of ink inducing members may be arranged. In such a case, the protection device must be able to seal the plurality of ink inducing members.

Furthermore, in such a case, the space between the funnel members in the horizontal direction is limited. With the elongated configuration as described above, the elongated part can be arranged at the upper part and be utilized as the leverage fulcrum when removing the protection device from the storage main body. Due to the aforementioned configuration, the protection device can be easily removed

It is also preferable that the supporting beam is made of a pliable material and can be resiliently bent in the vertical direction with respect to its axis direction.

With the resilient supporting beam, the elastic cap can engage with the ink inducing member even when the ink inducing member and the supporting beam are slightly misaligned. Even in such a case, the sealing of the ink inducing member is maintained.

It is also preferable that the supporting beam and the funnel member are made of a pliable material as one hollow component.

The pliancy of the supporting beam and the funnel member enables the elastic cap to seal the ink inducing member even when a slight misalignment exists between the ink inducing member and the supporting beam. Furthermore, since the supporting beam and the funnel member are formed with a hollow interior, the pliancy thereof is improved. Along with the supporting beam and the funnel member, the device's main body can also be made of a pliable material as one component.

It is also preferable that the elastic cap includes a brim portion, and the elastic cap is detachably inserted inside the funnel member with the brim portion at the supporting beam side.

During the removal of the protection device, the elastic cap is pulled towards the ink inducing member along with friction. Such a configuration as described above prevents the elastic cap from falling out of the funnel member in the course of removing the protection device.

It is also preferable that a concave portion is formed at a connecting section of the supporting beam and the funnel member, and the brim portion of the elastic cap engages with the concave portion.

In the configuration described above, the brim portion engages with the concave portion. In addition to the pulling force exerted on the elastic cap during the removal of the protection device, the elastic cap is also pressed towards the side of the opening by the ink inducing member during the insertion of the protection device. Such a configuration as described above prevents the elastic cap from falling out of the funnel member in the course of inserting and removing the protection device.

It is also preferable that the protection device further includes a regulation plate horizontally connected to the main body with respect to the surface at which the supporting beam is connected.

With the regulation plate standing on one surface in one direction, for example, on the top surface of the device main body in the upper direction, it can be utilized to recognize the improper positioning of the protection device. For example, if the protection device is inserted with its bottom side up, the regulation plate can prohibit the funnel member from covering the ink inducing member. Such misalignment can be recognized easily, thus preventing damage of the ink inducing member.

With the aforementioned configuration of the regulation plate, it allows the movement of the protection device in the horizontal direction with respect to the regulation plate.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a perspective view of a multi-function device of the present embodiment.

FIG. **2** shows a plane view of a housing (main body) with the upper case removed.

FIG. **3** shows a cross sectional view of a printer.

FIG. **4** shows a perspective view of a printer.

FIG. **5** shows a perspective view of an ink cartridge storage unit.

FIG. **6**A shows a front view of an ink cartridge storage unit, and FIG. **6**B shows a cross sectional view along the line VIb-VIb of FIG. **5**.

FIG. **7**A, FIG. **7**B and FIG. **7**C show perspective views of a connector from different angles.

FIG. **8** shows a cross sectional side view of an ink cartridge installed in an ink cartridge storage unit.

FIG. **9** shows a cross sectional side view of an ink cartridge being removed from an ink cartridge storage unit.

FIG. **10**A, FIG. **10**B, FIG. **10**C and FIG. **10**D show perspective views of a protection device from different angles.

FIG. **11** shows a perspective view of a protection device installed in an ink cartridge storage unit.

FIG. **12**A shows a front view of an ink cartridge storage unit with a protection device installed, and FIG. **12**B shows a cross sectional side view of FIG. **12**A.

FIG. **13**A shows an enlarged cross sectional side view of an ink inducing tube and a protection device, and FIG. **13**B shows an enlarged cross sectional front view of an ink inducing tube and a protection device.

FIG. **14** shows an enlarged and notched cross sectional view of a storage cover and the rear portion of the protection device.

DETAILED DESCRIPTION OF THE INVENTION

The preferred embodiment of the present invention will be described in detail below with reference to the figures.

FIG. **1** shows a perspective view of a multi-function device of the present embodiment. As shown in FIG. **1**, the present invention is incorporated into a multi-function device **1** (it may also be referred to as MFD **1** in the description below) in the present embodiment. The MFD **1** comprises printing function, scanning function, copying function, facsimile function, etc. The MFD **1** is connected to a computer not shown in the figures, and operates the above-mentioned functions according to the orders and data sent therefrom. The MFD **1** is also able to connect to an external device, such as a digital camera, and perform printing functions according to the orders and data sent therefrom.

In the descriptions below, the expressions regarding the front and rear directions (that is, the direction corresponding to the Y axis in FIG. **1**) will be described with respect to the side where the opening **2***a* of the housing **2** is defined as the front side. The expressions regarding the left and right directions (that is, the direction shown with X axis in FIG. **1**) will be described with respect to the front view of the MFD **1**.

The MFD **1** comprises a box-shaped housing **2** made of synthetic resin. At the front side of the housing **2**, a slot member **6** is positioned. Memory devices or media such as memory cards can be inserted into the slot member **6**. The MDF **1** can operate its printing function according to the data stored therein.

Above the slot member **6**, an operation panel **14** is situated on the upper front part of the housing **2**. The operation panel **14** comprises operation buttons and a LCD monitor. Operation orders can be inputted by manually operating the operation panel **14**.

A scanner **12** is fixed on the upper part of the housing **2** of the MFD **1**. The scanner **12** is utilized in operating functions such as the copying function and the facsimile function.

On the top surface of the scanner **12**, a glass plate (not shown in the figures) is arranged, and a Contact Image Sensor (CIS, not shown in the figures) is installed underneath the glass plate. The CIS is able to move in the leftward and rightward direction, that is, the direction corresponding to axis X in FIG. **1**.

The scanner **12** has a scanner cover **13** arranged on its top. The scanner cover **13** is hinged to the main body of the scanner **12** at the rear edge. The scanner cover **13** can rotate with respect to the glass surface between a closed state that the scanner cover **13** covers the glass plate, and an opened state that exposes the glass plate. The scanner cover **13** also includes an auto document feeder (ADF) **13***a*.

In the lower part of the housing **2** that is shown in FIG. **1**, a printer **7** is arranged below the scanner **12**. Below the printer **7**, a paper feeding mechanism is arranged. FIG. **3** shows a cross sectional view of the printer **7** and the lower part of the housing **2**. As shown in FIG. **3**, inside the bottom part of the housing **2**, a space for storing the paper feed-in cassette **3** is provided. This space has an opening **2***a* located in the front side of the housing **2** (also see FIG. **1**). The paper feed-in cassette **3** can be inserted into and detached from the housing **2** from the front side through the opening **2***a* in the horizontal direction with respect to the bottom surface of the housing **2**.

In the present embodiment, a plurality of sheets of printing paper P can be stored in the paper feed-in cassette **3** in a stacked state. The paper feed-in cassette **3** is able to store printing paper P of various sizes, such as A4 size, letter size, legal size, postcard size, etc. The plurality of sheets of printing paper P can be stacked with the shorter side (the widthwise side) of the stack of printing paper P perpendicularly intersecting with the feed-in direction of the printing paper P (the direction corresponding to axis Y in FIG. **1**).

In the upper part of the paper feed-in cassette **3**, a secondary feed-in cassette **3***a* is arranged. The secondary feed-in cassette **3***a* can store stacks of paper of small sizes, and is slidable, in the Y-axis direction, on the paper feed-in cassette **3**. The paper feed-in cassette **3** and the secondary feed-in cassette **3***a* shown in FIG. **3** are abbreviated in FIG. **1**.

As shown in FIG. **3**, at the rear side of the paper feed-in cassette **3**, an inclined separator **8** is arranged. A paper feed-in arm **6***a* facing the inclined separator **8** is equipped on the housing **2**. That is, one end of the paper feed-in arm **6***a* is connected to the housing **2**, and the other end of the paper feed-in arm **6***a* rotates in the up and down direction with respect to the end connected to the housing **2**. At the other end

of the paper feed-in arm **6***a*, a paper feed-in roller **6** is arranged. The paper feed-in roller **6** and the inclined separator **8** send out the topmost sheet of printing paper P from the stack in the paper feed-in cassette **3** at a time.

The sheet of printing paper P separated from the stack is fed through the U-shaped passage **9** (that is, the paper feeding passage) in the upper direction. The printing paper P is fed into the printer **7**, which is located on the upper rear part of the housing **2** and above the paper feed-in cassette **3**. The printer **7** operates the printing function, and prints images on the printing paper P by discharging ink thereon.

After the printing paper P is conveyed through the printer **7**, and an image is printed thereon, the printing paper P is fed out onto a paper feed-out member **10**. The paper feed-out member **10** is located above the paper feed-in cassette **3**. The paper feed-out member **10** includes a feed-out opening **10***a*. The feed-out opening **10***a* is included in the front opening **2***a* as the upper part thereof.

As shown in FIG. **1**, next to the front opening **2***a*, an ink cartridge storage unit **15** is arranged. The ink cartridge storage unit **15** is fixed to the bottom surface of the main body. Furthermore, a cover **2***b* for the ink cartridge storage unit **15** is hinged to the housing **2**. The cover **2***b* is connected to the housing **2** with a hinge that connects a bottom edge of the cover **2***b* and a part of the lower front side of the housing **2**. As shown in FIG. **1**, the cover **2***b* can rotate with respect to the ink cartridge storage unit **15** between a closed state that the cover **2***b* covers the ink cartridge storage unit **15**, and an opened state that the ink cartridge storage unit **15** is exposed. The ink cartridge storage unit **15** is connected to the printer **7** with a relaying member to provide ink thereto.

FIG. **2** shows a plane view of the lower part of the housing **2** with the upper part (the scanner **12**) removed. The printer **7** is connected to the ink cartridge storage unit **15** by a plurality of ink tubes **20**. The ink stored inside the ink cartridge storage unit **15** is provided to the printer **7** through the ink tubes **20**. Each ink tube **20** is arranged to provide ink of one color type; that is, as shown in FIG. **2**, FIG. **4** and FIG. **5**, four types of ink are stored in the ink cartridge storage unit **15** in the present embodiment.

FIG. **4** shows a perspective view of the printer **7**. As shown in FIG. **2** and FIG. **4**, the printer **7** is supported by a main frame **21**. More specifically, the printer **7** is supported by a pair of side plates **21***a* and **21***b* of the main frame **21**, which are located on the left and right side respectively. The printer **7** farther includes a first guiding member **22** and a second guiding member **23**. The first and second guiding members **22**, **23** are flat plates that extend in the direction of axis X (shown in FIG. **1**). The first and second guiding members **22**, **23** slidably support a carriage **5**. The carriage **5** includes a print head **4**, and is configured so that it is able to slide back and forth in the direction of axis X. The carriage **5** is moved by a timing belt **25** and a carriage motor (CR motor) **24**. The timing belt **25** is a loop belt wound around a pulley, and it is extending above and parallel to the second guiding member **23**. A part of the timing belt **25** is fixed to the carriage **5**. The driving force from the CR motor **24** is transmitted to the timing belt **25** through the pulley; thus the carriage **5** is driven by the driving force from the CR motor **24**. In the present embodiment, the CR motor **24** is a DC motor. However, it can be substituted by other types of motors (a stepping motor, for example).

Under the print head **4** and between the first and second guiding members **22**, **23**, a platen **26** is arranged. The platen **26** has the shape of a flat rectangular plate, and it supports the sheet of printing paper P that is conveyed underneath the print head **4**. The first guiding member **22** is located on the upstream side and the second guiding member is located on the downstream side with respect to the direction the sheet of printing paper P is conveyed (that is, the direction shown with arrow A in FIG. **3**).

A tape scale (not shown in the figures), a component of an optical linear encoder utilized to detect the position of the carriage **5** in the direction of axis X and the speed at which it is moving in that direction, is also included in the printer **7**.

A pair of resist rollers **27** is arranged along the widthwise direction of the platen **26**. The platen **26** is located between the pair of resist rollers **27** in the vertical direction (the up and down direction). The pair of resist rollers **27** is located on the first guiding member **22** side with respect to the direction of axis Y. As shown in FIG. **3**, the pair of resist rollers **27** feed the sheet of printing paper P in between the platen **26** and the print head **4**.

On the downstream side of the platen **26**, a feed-out roller **28***a* and a spur roller **28***b* are arranged. After being conveyed underneath the print head **4**, the sheet of printing paper P is fed out to the paper feed-out member **10** by the feed-out roller **28***a* and the spur roller **28***b*.

Furthermore, as shown in FIGS. **2** and **4**, an ink receptor **29** is arranged on one side of the platen **26**, and a maintenance unit **30** is arranged on the other side of the platen **26**. In the present embodiment, the ink receptor **29** is arranged between the side plate **21***a* and the platen **26**, and the maintenance unit **30** is arranged on the right side of the side plate **21***b*. The ink receptor **29** is utilized as a flushing position for the print head **4**. The print head **4** (or the carriage **5**) periodically slides to the flushing position, that is, above the ink receptor **29**, during the printing operation in order to discharge ink for the purpose of preventing nozzle clog. The ink receptor **29** receives the ink discharged therefrom.

The maintenance unit **30** is utilized for a stand by position for the carriage **5**. The maintenance unit **30** is operated in processes such as a process for selectively absorbing ink of different colors, a recovery process for removing air bubbles from a buffer tank (not shown in the figures) arranged above the print head **4**, and/or the like.

Though not shown in the figures, the maintenance unit **30** further includes a wiper member. The wiper member cleans the nozzle surface of the print head **4** when the carriage **5** slides into the printing region (that is, above the platen **26**) from the stand by position.

The configuration of the ink cartridge storage unit **15** will be described below. FIG. **5** shows a perspective view of the ink cartridge storage unit **15**. The ink cartridge storage unit **15** includes a storage main body **74** for storing a plurality of ink cartridges **60**. In the present embodiment, four ink cartridges **60** can be stored, aligned in parallel, in the direction of axis X inside the storage main body **74**. Four storage covers **76** are connected to the lower front part of the storage main body **74**. Each storage cover **76** rotates with respect to the main body **74** between an opened state (shown with the second storage cover **76** to the left in FIG. **5**), and a closed state (shown with the storage covers **76** in FIG. **12**A).

The storage main body **74** of the ink cartridge storage unit **15** is made of resin, for example, in a rectangular parallelepiped shape. FIG. **6**A shows a front view of the ink cartridge storage unit **15**, and FIG. **6**B shows a cross sectional view along the line VIb-VIb of FIG. **5**. As shown in FIGS. **5**, **6**A and **6**B, the storage main body **74** includes a bottom plate **80**, a pair of side plates **81**, a top plate **82**, and a rear plate **79**. The side plates **81** are vertically connected to the bottom plate **80**, and the top plate **82** is attached on top of the side plates **81**. The side plates **81** are connected by the rear plate **79**, which is arranged at the upper part (a part close to the top plate **82**) of

the rear wall. The front part of the storage main body **74** has an opening **74***a*, where the ink cartridges **60** can be inserted or removed therefrom. Inside the storage main body **74**, as shown in FIG. **6**, a plurality of separators **75** is arranged (also see FIGS. **9**, **11** and **12**B). The separators **75** divide the space inside the storage main body **74** into several storage rooms **78**, into which the ink cartridges **60** can be installed respectively. Depending on the number of ink cartridges **60**, a corresponding number of separators **75** are arranged inside the storage main body **74**.

In the present embodiment, the storage main body **74** has four storage rooms **78**. Each storage room **78** is configured so that the corresponding ink cartridge **60** can be inserted and removed from the front side opening **74***a*. The interior surfaces of the storage room **78** are formed to fit with the corresponding surfaces of the ink cartridge **60**. Due to this configuration, the ink cartridge **60** can be stored stably in the storage room **78**.

The separator **75** does not need to distinctly divide the storage rooms **78**. The separators **75** can be formed as ribs in order to separate the storage rooms **78** at least at the rear side (the side closest to the rear plate **79**). It is preferred that the bottom plate **80**, the side plates **81**, the top plate **82**, the rear plate **79** and the separator **75** to be formed as one component.

In the present embodiment, as clearly shown in FIGS. **6**A and **6**B, the storage main body **74** has a pair of guiding rails **80***a* arranged at the surface of the bottom plate **80**. Each guiding rail **80***a* has a flat surface, and the ink cartridge **60** is placed thereon. The guiding rails **80***a* extend from the front opening **74***a* towards the rear plate **79**, and guide the ink cartridge **60** along that direction in the course of inserting and removing the ink cartridge **60** from the storage main body **74**. Moreover, a groove **80***b* is formed between the pair of guiding rails **80***a*. In a case where an ink leak occurs, the groove **80***b* between the pair of guiding rails **80***a* is utilized as a drain for the leaking ink.

Furthermore, as shown in FIG. **6**B, the cartridge storage unit **15** includes a connector **62**. The connector **62** connects the ink cartridge **60** and the ink tube **20**. FIG. **7**A, FIG. **7**B and FIG. **7**C show perspective views of the connector **62** from different angles. The connector **62** includes a rectangular plate **62***a*, and a plurality of ink inducing tubes **63**. The ink inducing tube **63** is in the shape of a needle or a tube, and is formed in unity with and penetrating through the rectangular plate **62***a*. The ink inducing tube **63** is connected to one end of the ink tube **20**, as shown in FIG. **6**B. The other end of the ink tube **20** is connected to the print head **4** of the carriage **5** (see FIG. **2**), and is configured to provide the ink to the print head **4**. The rectangular plate **62***a* fixedly covers the lower part of the rear plate **79** of the storage main body **74**, and the other end of the ink inducing tube **63** (the protruding part shown in FIGS. **7**A, **7**B and **7**C), vertically protrudes inside the storage main body **74** with respect to the rear plate **79**. A plurality of arc-shaped guiding ribs **69** is arranged on the outer periphery of the ink inducing tube **63**. The guiding ribs **69** are utilized to guide the ink cartridge **60** in the course of connecting the ink cartridge **60** to the ink inducing tube **63**.

In the present embodiment, the four aforementioned ink colors are utilized. Therefore, four sets of ink inducing tubes **63** and ink tubes **20** are arranged. The number of the sets can be configured to correspond to the number of ink cartridges **60** utilized for the printer **7**. For example, in a case where six to eight different colors are used, the ink cartridge storage unit **15** is configured to store six to eight ink cartridges, and a corresponding number of ink inducing tubes **63** and ink tubes **20** are arranged.

The configuration of the ink cartridge **60** will be described below. As shown in FIGS. **5** and **6**B, the ink cartridges **60** each includes a cartridge main body **64** made of synthetic resin. As is clear from FIG. **6**A, the cartridge main body **64** has the shape of a rectangular box whose front view area (its width) is narrow, and the vertical height is long. The cartridge main body **64** is formed as a rectangular parallelepiped box with thin walls, and a space for storing ink cartridges is formed therein. The cartridge main body **64** is composed of two tray shaped members. The two tray members are welded or adhered to compose the left and right side of the main body **64**. The width of the cartridge main body **64** is defined by the distance between two walls parallel to the direction of axis Y.

As described above, the ink cartridge storage unit **15** of the present embodiment is able to store four ink cartridges **60** of different colors, each holding different colors of ink: black (BK), cyan (C), magenta (M) and yellow (Y). When the ink cartridges **60** are installed inside the storage main body **74**, they can be arranged parallel in the aforementioned color order. Furthermore, as clearly shown in FIG. **1**, FIG. **5** and FIG. **6**A, the ink cartridge **60** for BK ink is larger than the other ink cartridges **60** in the widthwise direction (the direction of axis Y). Such a configuration is based on the fact that the demand for black ink exceeds the demands for other colors, thus the black ink is consumed most. In the present embodiment, the construction and configuration of the ink cartridges **60** for colors other than black is identical.

At the rear side of the main body **64** (the side facing the rear plate **79** of the storage main body **74**), an air valve **85** is arranged on the upper part (see FIG. **6**B). In the present embodiment, a checking valve (not shown in the figures) is installed inside the air valve **85**. Furthermore, a pushing rod **84** is connected to the air valve **85**. The pushing rod **84** protrudes towards the inserting direction of the ink cartridge **60**. The pushing rod **84** is able to move in the inserting direction between a state of protruding outside the air valve **85** and a state of being pushed back inside the air valve **85**. When the ink cartridge **60** is inserted into the storage main body **74**, and the rear side surface of the ink cartridge **60** makes contact with the rear plate **79**, the pushing rod **84** is pushed back inside the air valve **85**. As a result, the checking valve inside the air valve **85** opens. When the ink cartridge **60** is removed from the storage main body **74**, that is, when the rear surface of the cartridge main body **64** is pulled away from the rear plate **79**, the pushing rod **84** is brought out into the state of protruding outside the air valve **85**. The checking valve is closed as the result of the pushing rod **84** being pulled out of the air valve **85**.

Furthermore, at the lower part of the rear side surface of the cartridge main body **64**, an ink inducing valve **65** is arranged. The ink inducing valve **65** is arranged inside a guiding tube **65***a* (see FIG. **6**B). In the course of inserting the ink cartridge **60** into the storage main body **74**, the guiding ribs **69** of the connector **62** guide the ink inducing valve **65** during the course of the insertion. As the result of the insertion, the arc-shaped guiding ribs **69** are engaged with the outer periphery of the guiding tube **65***a*. Thus, the ink inducing valve **65** of the ink cartridge **60** and the ink inducing tube **63** of the ink cartridge storage unit **15** are connected. Ink is provided from the ink cartridge **60** to the print head **4** through the aforementioned connection of the ink inducing valve **65** and the ink inducing tube **63**, and through the ink tube **20** connected to the ink inducing tube **63**.

As shown in FIG. **6**B, on the rear side surface of the cartridge main body **64**, a sensed portion **66** is arranged. Inside the cartridge main body **64**, a movable device not shown in the figures that can function as a sensed actuator is

arranged. The actuator is able to move in accordance with the amount of ink remaining inside the cartridge main body **64**.

On the other hand, the storage main body **74** includes a liquid level sensor **87** (for example, a photo interrupter). The liquid level sensor **87** is arranged on the rear side surface of the main body **74**, at a place where the liquid level sensor **87** is able to detect the movement of the actuator via the sensed portion **66**. The liquid level sensor **87** detects whether the actuator is within the sensing range, and monitors the level of ink remaining.

As shown in FIG. **9**, a groove **68** is formed at the top surface of the cartridge main body **64**. The groove **68** extends in the lengthwise direction of the cartridge main body **64**. Furthermore, a concave portion **68***a* is formed in an approximately intermediate area of the groove **68**. The concave portion **68***a* is a v-shaped indentation, including the angled surfaces at the front side and the rear side respectively.

The aforementioned L-shaped swing arm (not shown) arranged on the top plate **82** of the storage main body **74** is guided along the groove **68** in the course of installing and removing the ink cartridge **60** from the storage main body **74**. In the course of removing the ink cartridge **60** from the storage main body **74**, the ink cartridge **60** is slightly pulled out of the storage room **78** by the rotation of the storage cover **76**. Then, when the distal end of the swing arm is engaged with the concave portion **68***a*, the ink cartridge **60** is further pushed out to a position, for example, as shown in FIG. **9** by the force transmitted from the swing arm.

Furthermore, as shown in FIG. **8** and FIG. **9**, on the bottom surface of the cartridge main body **64**, guiding grooves **67** are arranged. The guiding grooves **67** extend along the insertion direction; that is, the lengthwise direction of the cartridge main body **64**. Each guiding groove **67** is concavely formed in the boundary corner of the bottom surface and the side surface of the main body **64** (also see FIG. **5**).

In the present embodiment, the guiding grooves **67** are formed in the left and right corners respectively. As shown in FIG. **9**, the guiding groove **67** includes a first portion **67***a*, a second portion **67***b*, and a third portion **67***c*. The first portion **67***a* is a shallowly concaved groove. One end of the first portion **67***a* is open towards the rear side surface of the storage main body **74**, when the ink cartridge **60** is installed in the storage main body **74**. The second portion **67***b* is arranged in between the first portion **67***a* and the third portion **67***c*. The second portion **67***b* is a groove whose size enlarges towards the third portion **67***c*; that is, the depth of the second portion **67***b* deepens towards the third portion **67***c*. The groove of the third portion **67***c* is the deepest of the aforementioned portions **67***a*, **67***b* and **67***c*. The bottom surface of the third portion **67***c* is parallel to the remaining bottom surface **64***b*, that is the surface areas in which grooves have not been formed, of the cartridge main body **64**. The distal end of the third portion **67***c* is covered by a hook member **64***a*, so that the groove **67** is not open towards the front side of the storage main body **64** (that is, the front opening **74***a* side of the ink cartridge storage unit **15**). Therefore, the left and right corners of the bottom surface of the cartridge main body **64** are both curtailed by the guiding grooves **67**, with the bottom surface **64***b* remaining (see FIG. **5** and FIG. **6**B).

In the course of installing the ink cartridge **60**, the bottom surface **64***b* is placed on the aforementioned guiding rails **80***a*, and guided thereon. The vertical position of the guiding rails **80***a* is configured so that the ink inducing tube **63** can be inserted into the ink inducing valve **65**.

When the ink cartridge **60** is installed inside the storage room **78**, the pushing rod **84** is pressed against the rear plate **79** and releases the air valve **85** of the ink cartridge **60**. The liquid level sensor **87** is engaged with the sensed portion **66** of the ink cartridge **60**. Such a configuration enables air to be induced into the cartridge main body **64** via the air valve **85**, and the ink stored inside the cartridge main body **64** flows out to the print head **4** side.

As shown in FIG. **5** and FIG. **11**, at the front opening **74***a* of the main body **74**, a plurality of storage covers **76** is arranged. Each storage cover **76** corresponds to one of the storage rooms **78**. The storage covers **76** are made of materials such as synthetic resin.

The storage cover **76** is connected to the lower edge of the storage main body **74** with a shaft **94**. The storage cover **76** can rotate with respect to the storage main body **74** between the opened state and the closed state (see FIG. **5**). In the opened state, the ink cartridges **60** can be inserted or removed through the front opening **74***a*. In the closed state with the ink cartridges **60** installed, the storage covers **76** holds the ink cartridges **60** in a stable position.

As clearly shown in FIG. **9**, the storage cover **76** includes a cover main body **89**, a weight support member **90**, a lock member **91**, and a lock release lever **92**. The aforementioned components are made of synthetic resin.

On the lower end (the end connected to the storage main body **74**) of the storage cover **89**, a lever member **77** is formed on both the left and right side respectively (see FIG. **8**). Each lever member **77** includes an elongated portion **77***a* and a curved portion **77***b*. The elongated portion **77***a* extends vertically from the cover main body. Simultaneously, the curved portion **77***b* extends from the distal end of the elongated portion **77***a*, and curves at a 90 degrees angle therefrom. As shown in FIG. **8**, the curved portion **77***b* extends parallel to the cover main body **89** in the upper direction. The distal end of the curved portion **77***b* protrudes higher in the vertical direction than the top surfaces of the guiding rails **80***a*. Thus, as shown in FIG. **8**, the hook member **64***a* of the ink cartridge **60** is caught by the curved portion **77***b* when in the closed state. In the course of opening the storage cover **76**, the cover main body **89** and the lever member **77** are rotated frontward. The curved portion **77***b* slightly pulls out the ink cartridge **60** from the storage room **78** with the rotation of the curved portion **77***b*, and the shifting of the hook member **64***a* that accompanies the aforementioned rotation. In FIG. **8**, the amount the ink cartridge **60** shifts is shown as **W1**. The dotted line of FIG. **8** shows the opened state of the storage cover **76** and the ink cartridge **60** after being slightly pulled out of the storage room **78**.

As shown in FIG. **8**, during the process of shifting the storage cover **76** into the opened state, the curved portion **77***b* of the lever member **77** rotates in a counter clockwise direction with respect to the shaft **94**. The rotation causes an exterior surface **110** of the lever member **77** to move from a vertical standing state into a near-horizontal state with respect to the surface of the bottom plate **80**. The elongated portion **77***a* of the lever member **77** is configured in a certain length size, so that the exterior surface **110** is positioned slightly higher than the surface of the guiding rails **80***a*. In this case, the exterior surface **110** guides the ink cartridge **60** onto the guiding rails **80***a* as it is being inserted into the storage room **78**. This means that the lever member **77** functions as a component that pulls out the ink cartridge **60** from the storage room **78** during the removal process, and as a component that guides the ink cartridge **60** into the storage room **78** in the insertion process (see FIGS. **8** and **9**).

Though not shown in the figures, a swing arm is arranged on the surface of the top plate **82** of the storage main body **74**. The swing arm has an L-shape when viewed from the side, and is attached to the ceiling of each storage room **78** with a

spring **96** (shown in FIGS. **5** and **8**). When the ink cartridge **60** is installed inside the storage room **78**, the swing arm holds the ink cartridge **60** down in the vertical direction with respect to the bottom plate **80**. This means that a repulsive force from the ink cartridge **60** is exerted on the spring **96** during such state. FIG. **8** shows a cross sectional side view of the ink cartridge **60** installed in the ink cartridge storage unit **15**, and FIG. **9** shows a cross sectional side view of the ink cartridge **60** being removed from the ink cartridge storage unit **15**. When the storage cover **76** is opened, the ink cartridge **60** is pulled out to the position shown with dotted line in FIG. **8**. Then, the ink cartridge **60** is further withdrawn to a position, for example, as shown in FIG. **9**, by the force transmitted from the swing arm.

As shown in FIGS. **5**, **6**B, **8**, **9**, **11**, and **12**B, the weight support member **90** is slidably arranged on the interior surface (the surface side which faces the storage room **78** in the closed state) of the cover main body **89**. The weight support member **90** is suspended on the cover main body **89** with a compressed coil spring (not shown in the figures) so as to maintain a protruding aspect. Hence, when the storage cover **76** is in its closed state with the ink cartridge **60** installed inside the storage main body **74**, the weight support member **90** makes contact with the front side surface of the ink cartridge **60**. The weight support member **90** presses against the ink cartridge **60** in a vertical direction with respect to the interior surface of the cover main body **89**, and holds the ink cartridge **60** in a predetermined position inside the storage room **78**.

The lock member **91** is slidably arranged at the upper end of the cover main body **89**. The lock member **91** is able to slide horizontally with respect to the cover main body **89** within a predetermined range. As shown in FIG. **5**, the lock member **91** includes a hook portion **91***a* that protrudes vertically with respect to the cover main body **89**. The lock member **91** is suspended by a spring not shown in the figures, for the hook portion **91***a* to maintain the protruding posture. As shown in FIG. **6**B, the upper surface of the hook portion **91***a* is angled. Hence, in the course of the storage cover **76** shifting into its closed state, the angled upper surface of the hook portion **91***a* makes contact with the upper edge portion **74***b* of the storage main body **74**. As the storage cover **76** is rotated more towards the storage main body **74**, the hook portion **91** is pressed down by the upper edge portion **74***b*, and the lock member **91** slides downward. The hook portion **91***a* is inserted into the insertion hole **74***c* that is located behind the upper edge portion **74***b*. When the hook portion **91***a* is fully inserted in the insertion hole **74***c*, the hook portion **91***a* is released from the pressure against the upper edge portion **74***b*. Thus, the lock member **91** slides upward, suspending the storage cover **76** to maintain its closed state. FIG. **6**A shows the closed state of a storage cover **76** at the right most storage room **78**. The other storage rooms **78** are shown without the storage covers **76**.

As shown in FIGS. **5**, **6**A and **6**B, the lock release lever **92** has the shape of a rectangular plate, and is arranged at the upper end of the exterior surface of the cover main body **89**. The lock release lever **92** is connected to the cover main body **89** with a supporting pin **92***a*, and rotates with respect to the cover main body **89** (see FIG. **8**). In the present embodiment, the lock release lever **92** is able to rotate between a state in which the lock release lever **92** is horizontal to the exterior surface of the cover main body **89** (see FIGS. **8** and **12**B) and a state in which the lock release lever **92** is vertical to the exterior surface of the cover main body **89** (see FIG. **5**). Within such a range, the lock release lever **92** can be rotated so that it is in an angled state (see FIG. **6**B).

The lock release lever **92** further includes a cam portion **92***b* (see FIG. **6**B). When the storage cover **76** is in its closed state, as shown in FIGS. **12**A and **12**B, the lock member **91** and the lock release lever **92** are in horizontal position with respect to the cover main body **89**. The lock release lever **92** is pulled downward from the horizontal state into either the angled or vertical state. The cam portion **92***b* makes contact with the lower part of the lock member **91**, as shown in FIG. **6**B, and presses the lock member **91** downward. The lock member **91** thus slides downward, releasing the hook portion **91***a* from the insertion hole **74***c*. The lock of the storage cover **76** is released, and the storage cover **76** can be rotated further into the opened state.

The ink cartridge **60** is replaced using the procedures described below. The storage cover **76** is opened, and the used ink cartridge **60** is removed from the storage room **78**. In the course of rotating the storage cover **76** into the opened state, the curved portion **77***b* of the lever member **77** catches the hook member **64***a* of the cartridge main body **64**, slightly sliding the cartridge main body **64** towards the front opening **74***a* side. The ink cartridge **60** can be easily withdrawn manually, because the rear part of the ink cartridge is pulled out of the storage room **78**. When a new ink cartridge **60** is installed into the storage room **78**, it is installed into the storage room **78** through the front opening **74***a*. The lower front side of the ink cartridge **60** is supported by the pair of lever members **77**, and guided by the members into the storage room **78**. Meanwhile, the bottom surface of the ink cartridge **60** slides along and above the guiding rails **80***a*. Within the configuration as mentioned, the ink cartridge **60** can be replaced easily and accurately.

With the new ink cartridge **60** installed inside the storage main body **74**, the storage cover **76** can be rotated towards the closed state. In the course of rotating into the closed state, the weight support member **90** makes contact with the front side surface of the ink cartridge **60**, and presses the ink cartridge **60** against the rear side surface of the storage room **78**. When the hook portion **91***a* of the lock member **91** is fully inserted into the insertion hole **74***c*, the storage cover **76** is positioned in its closed state.

After the ink cartridge **60** is installed inside the storage main body **74**, the ink inducing valve **65** of the ink cartridge **60** is connected to the ink inducing tube **63** of the connector **62**. The ink from the ink cartridge **60** is provided to the print head **4** through the ink inducing tube **63** and the ink tube **20**. Simultaneously, the air valve **85** is pressed against the storage main body **74**, and the pushing rod **84** is pushed back inside the air valve **85**. The checking valve is therefore opened, and air is induced into the cartridge main body **64** in accordance with the amount of ink provided to the print head **4**. With the aforementioned configuration, efficient ink provision for the printer **7** can be achieved.

In the course of shipping or transporting the MFD **1**, a protection device **40** is equipped inside the storage main body **74** instead of the ink cartridges **60**. The configuration of the protection device **40** is described in the description below.

The embodiment of the protection device **40** is shown in FIGS. **10**A to **10**D. FIG. **10**A, FIG. **10**B, FIG. **10**C and FIG. **10**D show perspective views of the protection device **40**, with each figure showing the protection device from a different angle. The protection device **40** of the present embodiment is configured to correspond to the ink cartridge storage unit **15** in which four ink cartridges **60** can be installed. Moreover, the protection device **40** of the present embodiment is configured to protect the ink inducing tube **63** that is arranged on the rear side surface that is vertical with respect to the bottom plate **80** of the storage main body **74**.

The protection device **40** includes a flat-shaped main body **41**, a plurality of supporting beams **42**, funnel members **43**

equipped at a distal end of each supporting beam **42**, and elastic caps **44** equipped inside each funnel member **43**. As shown in FIGS. **10**A to **10**D, the protection device **40** has a different shape compared to the sets of ink cartridges **60**. As shown in the aforementioned figures, the main body **41** of the protection device **40** does not need to be formed in a shape that is similar or identical to the shape of the ink cartridge **60**. The main body **41** of the present embodiment has a thin, rectangular parallelepiped shape.

The main body **41**, the supporting beams **42**, and the funnel members **43** are made of pliable materials such as synthetic resin, by using manufacturing methods such as injection molding, for example, and are formed as one component. The main body **41**, the supporting beams **42**, and the funnel members **43** can be made of other pliable materials, as long as the supporting beams **42** are resilient. The elastic caps **44** are made of a material with high pliability, such as compound rubber.

FIG. **12**A shows a front view of the ink cartridge storage unit **15** with the protection device **40** installed, and FIG. **12**B shows a cross sectional side view of FIG. **12**A. As shown in FIG. **12**B, each elastic cap **44** is cylindrically shaped, with a concave portion **44***a* formed at one end. The concave portion **44***a* (see FIG. **13**A) is configured to fit with the distal end of the ink inducing tube **63**. At the other end of the elastic cap **44**, that is, the end inserted into the funnel member **43**, a brim portion **44***b* is formed. The brim portion **44***b* has longer peripheral length than the main body portion of the elastic cap **44**, and protrudes outward.

Since the protection device **40** has a different shape from the ink cartridge **60**, it is not guided along the side surfaces of the separator **75**, as is the case with the ink cartridges **60**. In the course of inserting the protection device **40** inside the storage main body **74**, the protection device **40** can be inserted, aiming the funnel member **43** so as to cover the ink inducing tube **63**. The distal end of the ink inducing tube **63** is guided towards the concave portion **44***a* of the elastic cap **44** inside the funnel member **43**, and engaged therewith, while the rear side surface (that is, the surface facing the front opening **74***a*) of the main body **41** is pressed against the interior side surface of the cover main body. The main body **41** of the protection device **40** can be maintained in horizontal alignment with respect to the bottom plate **80** of the storage main body **74**, in such a manner that the main body **41** does not make contact with the guiding rails **80***a* nor the bottom plate **80**. The elastic cap **44** is firmly fit with the distal end of the ink inducing tube **63** thus; the protection device **40** is prevented from being misaligned with respect to the ink inducing tube **63**, or from falling off. A state in which the ink inducing tube **63** is tightly sealed can be maintained during the shipping or transporting the MFD **1**.

Furthermore, since the protection device **40** is suspended inside the storage room **78** with a pressing force exerted horizontally on the main body **41** from the storage cover **76** and the rear side surface of the storage main body **74**, it is preferred that the weight of the protection device **40** is minimized. Furthermore, in order to maintain the force exerted on the main body **41** efficiently, the main body **41** should comprise high pliability. For such reasons, the main body **41** and the supporting beams **42** are thinly formed in the present embodiment. Each supporting beam **42** is formed in a semicircular tube shape. The main body **41** has a structure similar to a hollow box with its bottom surface open. The main body **41** includes a top plate **41***a*, side plates **41***b* on left and right side respectively, a front plate **41***d*, and a rear plate **41***e*. At the rough center of the top plate **41***a*, a concave section **41***f* is formed. The concave section **41***f* is utilized as a grip in the course of inserting and removing the protection device **40** from the storage main body **74**. As clearly shown in FIGS. **10**B and **10**D, a plurality of reinforcing ribs **41***g* are formed on the bottom side surface of the main body **41** (that is, the exterior side surface of the concave section **41***f*). The reinforcing ribs **41***g* each connects the exterior side surface of the concave section **41***f* with the side plate **41***b* on left side, the side plate **41***b* on right side, the front plate **41***d*, and the rear plate **41***e* respectively.

In the closed state of the storage cover **76**, the storage cover **76** presses the main body **41** towards the rear side, and the funnel members **43** are pressed against the rear side surface of the storage main body **74**. Coincidentally, the elastic caps **44** cover and seal the ink inducing tubes **63**. The sealing between the ink inducing tubes **63** and the elastic caps **44** is enhanced by the pliability of the protection device **40** itself.

FIG. **13**A shows an enlarged cross sectional side view of the ink inducing tube **63** and a part of the protection device **40**, and FIG. **13**B shows an enlarged cross sectional front view of the ink inducing tube **36** and the protection device **40**. At the connecting section of the supporting beam **42** and the funnel member **43**, as shown in FIG. **13**A, a semicircular groove **45** and an engagement hole **46** are formed. The semicircular groove **45** engages with roughly half of the periphery of the brim portion **44***b* of the elastic cap **44**. The elastic cap **44** can be inserted within the engagement hole **46**, which is formed on the interior surface of the funnel member **43**. Such a configuration engages the brim portion **44***b* with the semicircular groove **45**, thus suspending the elastic cap **44** at the connecting section of the supporting beam **42** and the funnel member **43** even when the elastic cap **44** is pressed in its axial direction by the insertion of the ink inducing tube **63**. Furthermore, in the case where the protection device **40** is removed by manually pulling the concave section **41***f* (the grip), the elastic cap **44** remains in position due to the engagement between the brim portion **44***b* and the semicircular groove **45**.

Since the supporting beam **42** is formed as a semicircular tube, and the connecting section of the supporting beam **42** and the funnel member **43** has the engagement hole **46**, the elastic cap **44** can easily be inserted into the funnel member **43** via the hollow in the supporting beam **42** and into the engagement hole **46** which is connected to the aforementioned hollow section, even though the brim portion **44***b* has a longer peripheral length than the main body portion of the elastic cap **44**.

As shown in FIGS. **10**C, **10**D, and **11**, guiding protrusions **47***a* and **47***b* are formed on the left and right sides of the front plate **41***d* respectively. FIG. **11** shows a perspective view of the protection device **40** installed in the ink cartridge storage unit **15**.

The width of the guiding protrusions **47***a* and **47***b*, L**1** and L**2**, each corresponds to the width between the curved portions **77***b* of the lever member **77** for the left most storage room **78** and the right most storage room **78** respectively. In FIG. **11**, the width of the ink cartridge **60** that is inserted into the left most storage room **78** and the width of the ink cartridge **60** that is inserted into the right most storage room **78** differ, hence the width between the curved portions **77***b* differs as well. Thus, in accordance with the lever member **77**, the width L**1** and L**2** of the guiding protrusions **47***a* and **47***b* are different. With such a configuration, even in a case where one of the storage covers **76** on either the left side or the right side is closed first, one of the guiding protrusions **47***a* and **47***b* is engaged with the corresponding lever member **77**. One of the engaged guiding protrusions **47***a* or **47***b* is guided by the

lever member **77**, and the protection device **40** is horizontally pushed into the storage room **78**.

Furthermore, as shown in FIG **10**A, a fin **48** (a regulation plate) is formed at the corner of the top plate **41***a* and side plate **41***b* respectively on each side. It is preferable that the fins **48** have round corners or that the upper edges of the fins **48** are angled with the height of the fins **48** being lower on the supporting beam **42** side than the guiding protrusion **47***a*, **47***b* side. When the protection device **40** is inserted into the storage main body **74** in a wrong position, for example, with its topside down, the protection device **40** cannot be stably inserted with the fins **48** protruding in the lower direction. This is useful in recognizing the misaligned position of the protection device **40** in the course of inserting it into the ink cartridge storage unit **15**.

Moreover, in the case where the protection device **40** is manually inserted into the storage main body **74**, the concave section **41***f* is formed so that the index, middle, and third fingers can be put therein. The surface of the front plate **41***d* can be utilized as the holding position for the thumb. Such a configuration enables the protection device **40** to be held easily.

Furthermore, since the widths L**1** and L**2** of the guiding protrusions **47***a* and **47***b* are different, it is useful in recognizing a misaligned position of the protection device **40** in the course of inserting it into the storage main body **74**.

In the present embodiment, when the storage cover **76** is closed, the guiding protrusions **47***a* and **47***b* are pressed and supported by the interior side surface of the cover main body **89**. In order to ensure the accurate alignment of the protection device **40** against the ink inducing tube **63**, it is preferable that the guiding protrusions **47***a* and **47***b* each include a positioning protrusion **49***a*, **49***b* respectively. FIG. **14** shows an enlarged and notched cross sectional view of the storage cover **76** and the rear portion of the protection device **40** (also see FIGS. **10**C, **10**D, and **11**). The positioning protrusions **49***a*, **49***b* are formed on their respective guiding protrusions **47***a*, **47***b*, each on a surface that faces the storage cover **76** in the closed state. On the cover main bodies **89**, on the other hand, each includes a concave engaging portion **97** that corresponds to the positioning protrusions **47***a*, **47***b*. The positioning protrusions **47***a*, **47***b* are guided into the engaging portions **97** in the course of closing the storage cover **76**, thus the alignment of the ink inducing tube **63** and the protection device **40** is determined.

In such a case, as clearly shown in FIG. **14**, the positioning protrusions **47***a*, **47***b* have surface that narrows at an angle towards the distal end, and the distal end is rounded. Such a configuration of the positioning protrusions **47***a*, **47***b* enables the insertion into the engaging positions **97** to be easy. On the other hand, the engaging portions **97** may be tapered.

The fins **48** of the protection device **40** stand in the vertically upper direction with respect to the top plate **41***a* of the main body **41**. They are utilized to provide notification of a misalignment of the protection device **40** in the course of insertion. If the protection device **40** is inserted into the storage main body **74** upside down, the funnel member **43** is placed at a position higher than where the ink inducing tube **63** is located. Thus, in a misaligned state, the fins **48** block the funnel member **43** from engaging with the ink inducing tube **63**. Such a misalignment is easily recognized, and damage due to such a misalignment does not occur.

In the case where the fins **48** have the upper edge angled such that the height of the fins **48** on the supporting beam **42** side is lower than the height on the guiding protrusions **47***a*, **47***b* side, the protection device **40** is tilted when it is upside down. The funnel member **43** will be facing downward, hence the funnel members **43** cannot engage with the ink inducing tube **63** in such a state.

As shown in FIG. **13**A, in a sealed state where the ink inducing tube **63** is engaged with the concave portion **44***a* of the elastic cap **44**, a certain amount of clearance H**1** is formed in between the rim of the funnel member **43** and the guiding ribs **69** of the connector **62**.

Furthermore, as shown in FIG. **13**B, the guiding ribs **69**, that is, the arc-shaped guiding rib **69***a* and guiding ribs **69***b* with the notch **70** therebetween, have a radius of R**1** with the axis of the ink inducing tube **63** as center of the radius R**1**. The rim of the funnel member **43** is formed so as to cover up the arc-shaped guiding ribs **69**, with its rim in the shape of an egg, or an oval.

However, the rim of the funnel member **43** is not limited to the aforementioned shapes. It is able to have the form of an elongated round, covering the outer periphery of the guiding rib **69***a*. For such a configuration, the radius R**2** of the edge of the funnel member **43** can be made greater than R**1**, or, the rim of the funnel member **43** is biased outwards at a part corresponding to the guiding rib **69***a*, with respect to the axis of the guiding ribs **69** (see the dotted line in FIG. **13**B).

With such a clearance between the guiding ribs **69** and the funnel member **43**, even when an ink leak occurs around the guiding ribs **69**, the leaking ink can be prevented from dripping onto the funnel member **43**.

Furthermore, even in the case where the protection device **40** is firmly pressed frontward in the course of insertion, the funnel member **43** cannot be inserted further than where the guiding ribs **69** are arranged. The ink inducing tube **63** is thus protected, preventing any damage thereof.

In the course of removing the protection device **40**, the main body **41** can be lifted upward. During the lifting, a part of the interior surface of the elastic cap **44** that is pressed against the ink inducing tube **63** is constricted, and the upper rim of the funnel member **43** (that is, the part which has the radius R**2**) makes contact with the surface of the distal end of the guiding rib **69***a*. With the contact point acting as its leverage fulcrum, the main body **41** can be lifted higher. The elastic cap **44** is angled by the lifting, and the upper rim making contact with the distal surface of the guiding rib **69***a* slides downward while the position of the elastic cap **44** with respect to the ink inducing tube **63** is shifted with the constriction. As a result, the seal between the concave portion **44***a* and the ink inducing tube **63** is loosened. By forming the rim of the funnel member **43** in a partially elongated round, the funnel member **43** enables the elastic cap **44** to be unfastened from the ink inducing tube **63** with a small amount of effort.

In the case where the rim of the funnel member **43** is biased outwards, with respect to the axis of the guiding ribs **69**, the biased section (that is, the section with elongated radius R**2**) should be formed parallel to the direction in which the fins **48** are orientated. In such a case, when the protection device **40** is inserted inside the storage main body **74** in the proper position with the fins **48** standing vertically upward with respect to the bottom plate **80** of the storage main body **74**, damage resulting from the inappropriate removal of the elastic cap **44** can be reliably prevented.

In the present embodiment, the structure of the main body **41** of the protection device **40** is defined as a structure that partially occupies the space within the storage main body **74**. For example, the main body **41** and the supporting beams **42** occupy less than about half the space required for storing the sets of ink cartridges **60**.

The present invention can be embodied with the opening of the storage main body **74** formed in its top surface, with the

ink inducing tube **63** arranged on the bottom surface inside the main body **74**, orientated upward. The protection device **40** is then, in such a case, inserted through the opening at the top surface vertically with respect to the bottom side surface of the storage main body **74**.

The embodiments described above referred to a printer of the off-carriage type, however the present invention can also be embodied with a printer of on-carriage type.

What is claimed is:

1. A protection device for an ink cartridge storage unit comprising a storage main body with one side having an opening, and an ink inducing member arranged on a surface of the storage main body facing the side having the opening, in a manner that the ink inducing member vertically protrudes inside the storage main body with respect to the surface, the protection device comprising:

a main body;

a supporting beam including one end and another end opposite to the one end, the one end of the supporting beam being connected to the main body of the protection device;

a funnel member having a narrow conical end and a wide conical end, the narrow conical end being connected to the another end of the supporting beam; and

an elastic cap arranged inside the funnel member, wherein the elastic cap seals the ink inducing member in an engaged state;

wherein when the protection device is angled toward a direction, a part of the wide conical end corresponding to the direction makes contact with the surface where the ink inducing member is arranged and slides thereon.

2. The protection device as in claim **1**, wherein the ink cartridge storage unit includes a guiding rib arranged along outer periphery of the ink inducing member, and the guiding rib has a surface facing the opening;

wherein the funnel member is configured so that a clearance is maintained between the wide conical end of the funnel member and the guiding rib of the ink cartridge storage unit in the engaged state, and when the protection device is angled toward a direction, a part of the wide conical end corresponding to the direction makes contact with the surface of the guiding rib and slides thereon.

3. The protection device as in claim **1**, wherein:

a plurality of supporting beams ordered in a line is connected to a first surface of the main body of the protection device, the plurality of supporting beams aligned in a predetermined direction,

a part of the wide conical end is elongated in an orthogonal direction with respect to the lengthwise direction of the supporting beams, and

a plurality of guiding protrusions is connected to a second surface of the main body of the protection device that is opposite to the first surface, the plurality of guiding protrusions aligned in the predetermined direction.

4. The protection device as in claim **1**,

wherein the supporting beam is made of a pliable material and can be resiliently bent in the vertical direction with respect to its axis direction.

5. The protection device as in claim **4**,

wherein the supporting beam and the funnel member are made of a pliable material as one hollow component.

6. The protection device as in claim **1**, wherein:

the elastic cap includes a brim portion, and

the elastic cap is detachably inserted inside the funnel member with the brim portion on the supporting beam side.

7. The protection device as in claim **6**, wherein:

a concave portion is formed at a connecting section of the supporting beam and the funnel member; and

the brim portion of the elastic cap engages with the concave portion.

8. The protection device as in claim **1**, further comprising:

a regulation plate connected to the main body of the protection device with respect to the surface at which the supporting beam is connected,

wherein a height of the main body of the protection device is smaller than a height of an ink cartridge to be inserted into the ink cartridge storage unit.

9. The protection device as in claim **8**,

wherein the regulation plate allows the movement of the protection device in the horizontal direction with respect to the regulation plate.

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